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The new two-cylinder compound locomotive, built at the Altoona shops of the Pennsylvania R. R., has some decided novelties in its general appearance. The running board is just above the wheel hubs, the upper part of the driving wheels being inclosed in splashers, as in European practice. This brings the floor of the cab low down, and gives the engine a clumsy appearance. The tender has six wheels, on rigid axles, and is said to ride very easily. The engine is of the eight-wheel type, and hauls heavy express trains (sometimes composed of 12 Pullman cars) between New York and Philadelphia. The cylinders have piston valves in steam chests formed in the saddle between the cylinders, and the absence of the ordinary steam chests is very noticeable in the appearance of the engine, the running board being just above the cylinders. The Laird guides are used. The leading particulars of the engine are as follows:

Driving wheels, diam.	7 ft. 0 ins.
Truck wheels, "	3 " 6 "
Tender wheels, "	3 " 6 "
Wheelbase, driving	8 " 0 "
" eng. and tender	48 " 1 "
Length over engine and tender	58 " 6¼"
Weight on drivers (48,000 and 46,700 lbs.)	94,700 lbs.
" on truck	50,300 "
" of engine	145,000 "
" of tender	77,000 "
" of engine and tender	222,000 "
Cylinders	19 × 28 ins. and 31 × 28 ins.
Valves, piston, drain	1 ft. 0¼ ins.
Boiler, Belpaire, diam. of barrel	5 " 5 "
" height from rail to c. line	9 " 0 "
Working pressure	200 lbs.
Firebox, size inside	9 ft. 0 in. × 3 ft. 4 ins.
Tubes, 289; diam., 1⅞ ins.; length	11 ft. 9¼ ins.
Smokestack, height from rail to top	15 " 0 "
Capacity of tank	3,000 galls.
" of coal space	45,000 lbs.

The charter rights of the Blackwell's Island Bridge across the East River, between New York and Long Island City, which were secured by Dr. Thomas Ranney some years ago and again in a revised form about a year ago, are reported to have been purchased by Mr. Austin Corbin, President of the Long Island R. R. Co., who, it is stated, intends to proceed with the construction at once. The original charter provided for a highway bridge, with accommodations for foot passengers, and to these rights the last charter added the right to construct railway tracks. The object of the bridge is stated to be to give the Long Island R. R. direct access to New York city. The plans have been approved by the Federal government. In brief, these provided for a cantilever bridge, with three main spans 1,000 ft., 600 ft. and 1,100 ft. long, respectively, supported on four masonry piers, two of which will be on Blackwell's Island, and with a clear height of 135 ft. above high water. These spans, with the approaches, will make the structure about three miles long. Although the newspapers state that construction will begin at once, no very reliable basis is given for

A double-end locomotive has been built for the Brooklyn Bridge by the Baldwin Locomotive Works, of Philadelphia, Pa., for the purpose of hauling the trains between 1 a. m. and 5 a. m., when the cable plant is stopped. The present engines are four-wheel switch engines, weighing about 44,000 lbs., and two of these are required to haul a three-car train, the maximum grade being about 3%. The new engine weighs about 68,000 lbs., and has four driving wheels and a leading and trailing pony truck. Under favorable conditions of track, etc., it will haul a train of about 100 tons weight, or three to four loaded bridge cars, and if it proves successful others of the same type may be ordered. The engine is fitted with an exhaust muffler, a device which should long ago have been applied to mitigate the loud and annoying snorting of the present engines. The leading dimensions of the new engine are as follows:

Driving wheels, diam	3 ft. 6 ins.
Truck wheels, diam	2 ft. 3½ ins.
Wheel base, driving	5 ft. 0 in.
Wheel base, total	17 ft. 7 ins.
Length over bumpers	23 ft. 10¾ ins.
Weight on driving wheels	53,000 lbs.
Weight on trucks (7,500 lbs. each)	15,000 lbs.
Weight, total	68,000 lbs.
Cylinders	14 × 18 ins.
Cylinders, distance c. to c.	6 ft. 8 ins.
Connecting rod, length c. to c.	5 ft. 5¾ ins.
Valve gear	Stevenson link
Ports, steam, 12 × 1 in.; exhaust	12 × 2 ins.
Bridges	⅞ in.
Boiler, straight, radial stay; diam.	4 ft. 2 ins.
Boiler, height, rail to c. line	6 ft. 0 in.
Working pressure	160 lbs. per sq. in.
Firebox, size inside	4 ft. 6 11-16 ins. × 3 ft. 8⅝ ins.
Firebox, depth, front, 3 ft. 6¾ ins.; back, 3 ft. 5¾ ins.	
Grate area	16.84 sq. ft.
Tubes, 162; diam., 1⅝ ins.; length	6 ft. 10⅝ ins.
Heating surface, tubes	511.72 sq. ft.
Heating surface, firebox	62.06 sq. ft.
Heating surface, total	573.78 sq. ft.
Capacity of saddle tank	750 gallons
Capacity of coal bunker	2,240 lbs.
Smokestack, diameter	1 ft. 2 ins.
Smokestack, height of top from rail	13 ft. 1 7-16 ins.

The ships of the new U. S. Navy, completed since March 4, 1885, says Secretary Herbert in his first annual report, have cost $25,000,432, and $586,916 has been paid out in premiums on excess of contract requirements. Upon the ships now under construction or authorized to be built the sum of $26,701,656 has been expended or appropriated. The Secretary presents estimates for the next fiscal year amounting to $27,885,914, much of this being required for armor and guns. He points out that our navy has not yet reached a safe standard, even for peaceful times, and strongly urges the more rapid accumulation of torpedo boats, as these cost comparatively little and have a great destructive capacity. A bill for the reorganization of the line of the navy is in preparation for presentation to the incoming Congress.

The most serious railway accident of the week was a head collision of freight trains Nov. 28 near Conneaut, O., on the Lake Shore & Michigan Southern Ry. One train was pulling out from a side track after a passenger train had passed, and was run into by another freight train. Both engines and about 30 or 40 cars were wrecked. Two men were killed and two fatally injured.—Several freight train collisions have occurred recently on the Lehigh Valley R. R. owing to the disorganization of service by the strike.

A locomotive boiler explosion occurred Nov. 30 at Van Etten, N. Y., on the Lehigh Valley R. R. The engine was hauling a freight train, and low water is given as the reason of the explosion, the crown sheet having collapsed. Two men were injured.—At Eastland, Tex., the boiler of an engine on the Texas Pacific Ry. exploded Dec. 4, and three men were killed.

The shops of the New York Locomotive Co., at Rome, N. Y., were destroyed by fire Dec. 4, involving a loss of between $300,000 and $500,000.

A terrible railway collision occurred Nov. 29 in Italy, near Milan. An express train from Milan to Venice ran into a freight train which was 45 minutes behind time and was about to take the side track to let the express pass. The engines and two passenger cars were wrecked, and the cars caught fire and were almost entirely destroyed. Owing to the light construction of the cars, they were completely smashed and the passengers were terribly mangled. It is estimated that 30 persons were killed and about 150 injured. Most of those killed were emigrants on their way to take steamer for the United States.

The use of salt water for fire protection is to be investigated in Boston, the fire commissioners having requested the city engineer, Mr. Wm. Jackson, M. Am. Soc. C. E., to report on the feasibility and probable expense of putting a salt water pipe system through the district in greatest need of extra protection. In Engineering News of Jan. 5, 1893, there was described a separate fire protection system at Cleveland, O., where lake water is pumped through two or three lines of mains by means of an engine on the city fire boat. It is reported that Detroit, Mich., has recently completed 10,000 ft. of similar fire mains.

The New Croton Aqueduct case of O'Brien & Clark, relating to a claim for extra work performed, has been decided against these contractors by the Court of Appeals affirming the decision of the lower courts in favor of the city. This was a test case involving $732,312, but other claims aggregating from $5,000,000 to $8,000,000 depended upon it. The Court holds that the plaintiff had failed to prove facts sufficient to constitute a cause of action against the city of New York for any greater sum than that acknowledged to be due in the final certificate.

An independent barring engine is the rather novel attachment which the Wm. A. Harris Steam Engine Co., of Providence, has applied to a 1,000-HP. cross-compound Corliss engine now building for the Massachusetts Cotton Co. The barring engine is of about 5-HP. and turns the flywheel of the large engine by a pinion meshing with teeth on the flywheel rim. The barring engine is automatically thrown out of gear as soon as steam is turned on to the main engine.

The Long Island Water Supply case, which was discussed editorially in our issue of April 20, 1893, has been closed, probably finally, by the refusal of the Supreme Court to confirm Judge Pratt's decision setting aside the award which was made by the commission appointed for that purpose. As will be remembered the award of the Commission was set aside on the ground that the value of the company's franchise had not been taken into account. The Supreme Court rules that the company had no exclusive right under its charter, and that the city need not therefore reimburse the company for all the profits which it expected to make in the future up to the expiration of the franchise.

The Adams-Blair "direct process" of steel making appears to be again attracting attention, if we may judge from recent newspaper reports. Briefly, the process consists in reducing an iron ore by gas to form a metallic sponge, and using this sponge in the open-hearth furnace for steel manufacture. Details of the Adams-Blair process as at present operated are wanting, and the amount of capital which has been sunk in fruitless and foolish schemes of this sort leads one to regard them with suspicion. At the same time so good an authority as Mr. H. M. Howe, in his "Metallurgy of Steel," expresses the belief that the direct process may yet be able to compete with the blast furnace in furnishing material for the open-hearth furnace; and the continued commercial success of the Carbon Iron Co., which uses the Eames direct process, and turns out a very high grade of steel, is encouraging as to the possibilities in that direction.

Competitive plans for a $1,400,000 court house are asked by the city of Baltimore, Md. It is announced that the whole control and direction of the work is in the hands of a non-partisan commission of seven leading professional and business men and the mayor of the city. The commission has secured the services of Prof. William R. Ware, of Columbia College, as consulting architect, and under his advice the instructions for architects, the conditions governing the competition and the requirements of the building have been formulated. They are believed to be full, fair, complete and liberal. The architect whose design is adjudged the best will be employed as architect of the building, and will be paid a commission of 5% upon its cost, subject to pamphlet of instructions, giving full information. This pamphlet can be procured on and after Dec. 15, 1893, by addressing Ferdinand C. Latrobe, mayor, Baltimore, Md.

The official opening of the Manchester Canal is fixed for Jan. 1, 1894, though it is expected that the channel will be practically clear of obstructions on Dec. 7.

The New York Rapid Transit Commission has agreed upon a west side elevated railway line, from the Battery to the north city limits, with two and four tracks. The structure is to be sufficiently stable to permit the running of 5-car trains at 35 miles per hour, and the motive power is to be electricity or some power not requiring combustion on the line of the road. The franchise to construct and operate the part running along Broadway and the Boulevard is subject to the right to construct and operate the underground line laid out by the Commission along the same route. In other words, the plan for an elevated line does not shut out proposals for the underground. The engineers of the commission are instructed to prepare a general plan of construction for the elevated line, and it is supposed that a year will elapse before this franchise can be offered for sale.

THE EFFECT OF HARDENING ON THE ULTIMATE STRENGTH OF STEEL.*

By Elmer J. Bucknell, Decorah, Ia., Class of 1892, Rensselaer Polytechnic Institute.

High carbon or tool steel is designed for the manufacture of tools. The object in hardening tools is to secure hardness requisite for the cutting properties of the tools, and at the same time to give to them as much strength as possible. The hardening is accomplished by heating the steel to a certain degree of heat and then quenching in a bath. In a certain grade of steel there is a limit beyond which the steel cannot be hardened without impairing the strength and grain. If a tool requires greater hardness than can be given to a certain grade of steel without going beyond the limit, then a higher grade of steel must be used.

The tests here given will show the effect on the strength and grain of these particular grades, by hardening or quenching at different temperatures and in different baths.

It is usual in giving the temperatures at quenching to speak of them as "dull red," "cherry red," "orange," "bright orange," etc.; but as these colors are very indefinite the temperatures are given here in degrees. The temperatures were determined by the method of mixtures as follows: A piece of low steel 2 ins. long by ¾ in. diameter, was held beside the test piece while heating in the fire by a spiral coil. The coil was made of ¼-in. iron and was wound about the stem of the test piece, and at the center of the test piece the coil was made large enough to hold the small piece of steel also, so that when in the fire the pieces could be moved about and kept at the same temperature. As soon as the pieces were removed from the fire, they were separated. The test piece was quenched in the bath and the small piece was dropped into a tin vessel containing distilled water, and from the rise in temperature of the water, the temperature of the small piece of steel was determined.

In order to calculate the heat, the following data are necessary.

Weight and specific heat of small piece of steel.

Weight and specific heat of the tin vessel, and the weight of the water in the vessel.

Temperature of water before and after quenching.

When these are known, the formula given by Garrot:

$$M\,c\,(T-\theta) = (m + m'c')(\theta - t),$$

will give the temperature.

M = weight of small piece of steel.

c = its specific heat.

T = its temperature.

m = weight of water.

t = initial temperature of water.

θ = its final temperature.

m′ = weight of the tin vessel.

c′ = specific heat of tin vessel.

If T be given and c be the unknown, the same formula will give c.

The specific heat for this particular piece of steel was determined in this manner. The steel was heated in oil and T measured. Assuming c = c′;

then $$c = \frac{m\,(\theta - t)}{M\,(T-\theta) - m''\,(\theta - t)}.$$

A mean of seven tests gave the specific heat = 0.12.

This value for the specific heat was used in finding the temperature of the test pieces.

So long as the weight of the small piece of steel was practically constant, the formula would contain only two variable quantities, T and (θ − t); (θ − t was measured at each test.

Then T = (θ − t) × (a constant) + θ, so long as the weight of the small piece was practically constant. After each test the piece was weighed and if there was a reduction in weight sufficient to make a perceptible difference, then a complete solution of the formula was again made and the constant factor used as before. Therefore, in most cases one multiplication and one addition gave the required result.

The test pieces were of ¾ in. steel 10 ins. long, and 2 ins. at the center was turned down to a uniform diameter of from 0.5 to 0.6 in. The pieces were not taken longer than this, for the reason that it would be difficult to heat them uniformly in the fire used. The fire was a clean charcoal fire in an ordinary blacksmith's forge. The heat was applied to the pieces as uniformly as possible, and each was plunged perpendicularly into the bath by means of a short tin tube; the tube was so adjusted that when the test piece reached the bottom the lower end of the tube would be holding the upper end of the test piece. When the test piece dropped through the tube, its lower end was caught in a cup or receiver; therefore both ends of the piece were supported, while the middle was exposed to the bath; this made the condition of the plunge as nearly as possible the same for all the pieces.

*Graduating Thesis Awarded Honorable Mention in Engineering News Thesis Competition of 1892.

TESTS TO DETERMINE THE EFFECT OF HARDENING ON THE STRENGTH OF STEEL.

Test No.	Bath and temp. deg. F.	Tem. test piece when quenched. Deg. C.	Deg. F.	Area. Original. In.	Area. Fractured. In.	Area. % reduction.	Elastic limit (1 = 100). Actual.	Elastic limit (1 = 100). Lbs. per sq. in.	Elastic limit (1 = 100). % inc.	Maximum load (1 = 100). Actual.	Maximum load (1 = 100). Lbs. per sq. in.	Maximum load (1 = 100). % inc.	Breaking load (1 = 100). Actual.	Breaking load (1 = 100). Lbs. per sq. in.	Fracture.
Howe, Brown & Co.'s tool cast steel, 0.88% carbon.															
1				.3578	.3318	10.0	287	803	....	477	1,334	....	..	....	Fine granular.
2				.2107	.1794	15.3	150	711	....	280	1,328	....	278	1,549	" "
3				.2367	.2075	12.3	169	662	....	312	1,317	....	..	....	" "
4				.2316	.2067	10 7	155	670	....	310	1,338	....	..	....	" "
5	Water at 61°.	632	1,169	.2198	.1847	11 4	150	682	0.2	296	1,346	1.2	..	....	" " darker gray.
6		750	1,058	.2752	.2410	12.4	180	654	—3.8	380	1,380	3 8	..	....	" " " "
7		840	1,544	.2743	.2765	17.4	201	729	7.1	370	1,348	1.5	360	1,589	" " " "
8		850	1,562	.2827	.2198	22.2	200	707	3.9	367	1,298	— 2.7	350	1,592	" " " "
9		970	1,778	.2214	....	....	150	677	—0.4	240	1,084	—18.8	..	....	" " " "
10		975	1,819	.2790	.2156	22.7	200	716	5.3	350	1,254	— 5.7	340	1,577	" " " "
11		1,050	1,922	.2576	.2083	18.5	200	782	15.0	340	1,330	0.0	..	....	" " " "
12		1,058	1,936	.2463	....	00.0	250	1,015	49.2	330	1,339	0.7	..	....	" " " "
13		1,070	1,958	.2688	....	00.0	260	967	42 2	327	1,218	— 8.4	..	....	" "
14		1,100	2,012	.2489	....	00.0	200	803	18.8	260	1,044	—21.5	..	....	" "
15		1,100	2,012	.2019	....	00.0	..	....	....	60	297	—77.7	..	....	" "
16		1,120	2,048	.2669	....	00.0	250	936	37.6	398	1,491	—12.1	..	....	" "
17		1,165	2,129	.2561	....	00.0	..	....	....	143	558	—58.0	..	....	Coarser grained.
18		1,225	2,237	.2697	....	00.0	..	....	....	75	278	—79 6	..	....	" "
19		1,250	2,282	.2837	....	00.0	..	....	....	170	599	—54.9	..	....	" "
20		1,265	2,309	.2552	....	00.0	150	587	—13.7	168	658	—50.5	..	....	Quite coarse.
21		1,270	2,318	.2273	....	00.0	..	....	....	80	351	—73.6	..	....	" " white.
22		1,310	2,390	.3058	....	00.0	..	....	....	65	212	—84 0	..	....	" "
23		1,565	2,849	.2790	....	00.0	..	....	....	47	170	—87.2	..	....	Very " silvery.
24	Water at 146°.	875	1,607	.2223	.1817	18.2	170	764	12 3	288	1,295	— 2.6	..	....	Fine grained.
25		950	1,742	.1979	.1727	12.7	155	783	15.0	266	134	1.0	..	....	" "
26		1,135	2,075	.2165	.2165	00.0	..	....	....	130	600	—54.9	..	....	" " whiter.
27		1,170	2,138	.2251	....	00.0	..	....	....	114	505	—62.0	..	....	Coarse grained.
28		1,185	2,165	.2107	....	00.0	..	....	....	80	379	—71.5	..	....	" "
29		1,410	2,570	.2091	....	00.0	..	....	....	49	234	—82.4	..	....	" " silvery.
30		1,550	2,822	.2344	....	00 0	..	....	....	60	258	—80.6	..	....	Very coarse grained, silvery.
31	Water at 212°.	1,000	1,832	.2099	.1583	24.6	168	800	17.6	326	1,553	16 8	291	1,838	
32		1,000	1,832	.2091	.1619	22.6	176	841	23.6	305	1,458	9.6	296	1,766	
33		1,225	2,237	.2083	.2067	0.8	180	846	27.0	286	1,373	6.4	..	....	
34		1,225	2,237	.2083	.2067	0.8	150	720	5.8	254	1,219	— 8.3	..	....	
35		1,220	2,300	.2083	.2067	0.8	225	1,080	58.8	260	1,248	— 6.1	..	....	
36		1,260	2,300	.2273	.2256	0.8	205	901	32.5	280	1,232	— 7.4	..	....	
37	Oil at 77°.	990	1,814	.2206	.1626	26.3	145	657	—3.3	290	1,310	— 1.5	275	1.691	Fine grained.
38		1,000	1,832	.2248	.1562	30.5	176	782	15 0	298	1,326	— 0.4	280	1,792	" "
39		1,100	2,012	.2067	.1967	3.8	200	967	42.2	362	1,751	31.6	..	....	" "
40		1,200	2,192	.2292	.2140	6.3	140	657	—3.3	446	1,954	46.9	..	....	" "
41		1,370	2,462	.1987	.1224	3.2	200	1,006	47.9	375	1,887	41.9	..	....	" " rough, uneven.
42		1,375	2,507	.2273	.2231	1.8	230	1,011	48.6	444	1,953	46.9	..	....	" uneven fracture.
43		1,490	2,714	.2341	.2333	0.4	190	811	19.2	320	1,366	2.7	..	....	Dark gray, uneven fracture.
44	Water at 212°.	760	1,400	.2588	.2189	15.4	190	734	7.9	350	1,352	1.6	340	1,553	Fine grained.
45		990	1,814	.2003	.1979	1.2	160	798	17.3	358	1,787	34.3	..	....	" "
46		1,000	1,832	.2172	.2419	2.1	160	647	—4.8	410	1,628	24.6	..	....	" "
47		1,200	2,192	.1847	.1824	1 2	170	921	35 0	338	1,829	37.5	..	....	" "
48		1,260	2,300	.1995	.1979	0.8	190	952	40.0	258	1,293	— 2.7	..	....	Dark, uneven.
49		1,390	2,534	.2533	.2393	9.1	250	987	45.1	500	1,898	42.7	..	....	" "
50		1,435	2,615	.2790	.2780	0.4	340	1,218	79.1	430	1,541	15 8	..	....	Very dark, uneven.
51	Oil at 77°.	....	....	.2278	.2073	10.9	148	658	....	309	1,375	....	..	....	Fine granular.
52		....	....	.2023	.1698	15.1	146	692	....	280	1,384	....	275	1,619	" "
53	Water at 64°.	900	1,652	.2177	.1750	19.6	150	689	2.8	290	1,332	— 3.5	280	1,600	" "
54		1,050	1,922	.1963	.1963	00.0	..	....	....	160	815	—40.9	..	....	" "
55		1,200	2,192	.2099	.2099	00.0	..	....	....	106	505	—63.4	..	....	Coarse granular, white.
56		1,500	2,732	.2063	.2063	00.0	..	....	....	28	135	—90.9	..	....	Very coarse granular, white.
57	Water at 212°.	860	1,580	.2140	.1909	15.5	162	752	13.2	288	1,345	— 2.5	285	1.575	Fine grained.
58		890	1 634	.1825	.1500	17.7	160	876	30.7	234	1,282	— 7.1	230	1 633	" "
59		1,120	2,048	.2248	.1698	24.0	175	778	16.1	360	1,338	— 3.0	283	1,666	" "
60		1,150	2,102	.1963	.1720	12.3	195	993	48.3	310	1,579	14.4	..	....	" " uneven.
61		1,175	2,147	.1909	.1772	7.1	210	1,100	64.1	336	1,760	27.5	..	....	Dark " "
62		1,350	2,462	.2107	.2027	8.5	228	1,082	61.4	440	2,088	51.3	..	....	" "
63	Troy Iron & Steel Co.'s Bessemer steel, 0.18% carbon.	....	....	.2588	.0913	64.7	85	330	....	158	610	....	110	1,314	Silky, ¾ cup.
64		....	....	.2088	.0979	63.5	102	380	....	166	617	....	118	1,305	" "
65		....	....	.2875	.0990	65.5	110	382	....	175	610	....	120	1.212	" ⅛ "
66	Water at 77°.	900	1,652	.2463	.1134	53.9	104	422	11.0	208	828	35.0	163	1.437	" coarse, ½ cup.
67		1,080	1,976	.2415	.0962	60.2	132	540	42.1	200	818	34.0	153	1,590	" " " "
68		1,200	2,192	.2367	.1001	57.7	116	490	28.9	185	782	28.2	143	1.428	" " ⅛ "
69		1,375	2,507	.25 7	.0908	63.7	114	454	19.4	185	738	20.9	130	1.432	" " " "
70	Water at 212°.	807	1,485	.2377	.0855	63.8	106	448	17.9	154	650	6.5	109	1,275	" fine ½ "
71		1,040	1,904	.2350	.0840	60 4	98	417	9.7	152	647	5.7	102	1,214	" " ⅞ "
72		1,130	2,066	.2534	.0919	63.7	112	442	16.3	162	640	4.9	120	1,306	" " " "
73		1,150	2,102	.2507	.0881	64.8	105	419	10.2	163	650	6.5	114	1.294	" " full "
74		1,175	2,147	.3534	.0903	64.3	108	426	12.1	163	643	5.4	118	1.307	" " ⅞ "
75		1,320	2,408	.2463	.0844	65.7	108	434	14.2	170	690	13.1	115	1,762	" " full "
76		1,500	2,732	.2489	.0840	66.2	121	485	27.6	163	655	7.3	117	1,393	" " ⅛ "
77	Oil at 122°.	1,000	1,832	.2290	.0881	61.5	95	414	8.9	164	716	17.3	122	1.385	" " ¾ "
78		1,120	2,048	.2206	.0881	60.0	97	439	15.5	170	740	26.2	120	1,362	" " full "
79		1,140	2,084	.2380	.0860	63.8	90	378	—0.5	168	706	15.7	124	1,442	" " ¾ "
80		1,290	2,354	.2525	.0871	65.5	120	475	25.0	178	705	15.5	124	1,424	" " " "
81		1,395	2,543	.2350	.0765	67.5	120	509	33.9	165	700	14.7	113	1,477	" " ⅞ "

The water bath was sufficiently large to prevent any appreciable rise in temperature while quenching. With the exception of three pieces, all were tested as they were taken from the quenching bath; that is, without drawing or letting down.

The table contains the results of all the tests, and the headings in the table will explain the figures beneath them. The first tests are of Howe, Brown & Co.'s "Best Refined Cast Steel," chisel temper, about 0.88% of carbon. The carbon was determined by the color method; therefore, it can be relied upon as only the approximate amount, but is sufficiently near for this purpose. The first four tests are of untempered pieces; the average ultimate resistance is about 133,000 lbs. per sq. in.; the elastic limit, about 68,000 lbs., and the reduction of area, 12%.

No. 5 is a piece quenched in cold water at a low temperature, 632° C., a very dull red. The results show a slight increase in both ultimate resistance and elastic limit. No. 6, quenched at 750° C., shows a greater increase of ultimate resistance, but a slight decrease of the elastic limit. No. 7, quenched at 840° C., shows increase of both ultimate resistance and elastic limit.

At about 900° C. there seems to be a drop in the ultimate resistance, but it again rises at about 1,000° C. Then from this point it falls very rapidly, until at 1,565° C. it is only 17,000 lbs. per sq. in.

In the diagram for the Howe, Brown & Co. steel is shown a curve which will show to the eye approximately the relation between the temperature of quenching and the ultimate resistance. Starting at a point which represents 133,000 lbs. per sq. in., the curve does not show much variation in strength until the point which represents 1,000° C. is reached; but here it makes an abrupt turn and shows great loss of strength for a small increase of temperature. This curve was determined by taking mean strengths as near as could be judged, at certain temperatures.

The cold water tests show much irregularity. Most of the pieces broke at the ultimate or maximum load; the final load for a few of the pieces was, however, somewhat lower than the maximum, indicating considerable stretch in those pieces. The pieces quenched between the temperatures of 800° C. and 1,050° C. show considerable increase of reduction of area, but above 1,050° C. there was no apparent reduction of area.

The warm water tests begin at No. 24; these also show very irregular and unsatisfactory results. Beginning at a quenching temperature of about 1,150° C. the maximum load falls rapidly as the temperature increases. Nos. 31 and 32, 33 and 34, 35 and 36 were hardened in pairs, the two pieces being heated and quenched together. Nos. 32, 34 and 36 were then drawn or let down to a dark brown color to determine whether there is an increase or a decrease in the ultimate resistance due to drawing; in these cases it shows a decrease, but there are not enough tests to make this point positive.

It may be noticed that Nos. 31, 32, 33 and 34 were quenched at nearly the same temperatures, and (with the exception of being in pairs) under nearly the same conditions as Nos. 26, 27 and 28; yet they gave a much higher ultimate strength than Nos. 26, 27 and 28, for which there seems to be no apparent reason.

Next come the boiling water tests. Here there is more uniformity shown, and from the curve in the diagram it may be seen that from a quenching temperature of about 1,000° C. the ultimate resistance rises rapidly until it reaches its maximum at about 1,300° C. This maximum is not the highest given in the table, but is a mean of Nos. 40, 41 and 42. The curve now descends, but at about 1,500° C. the ultimate resistance is still above that of the untempered pieces.

The oil hardening comes next and shows a curve similar to that of the boiling water, although it does not give quite as high an ultimate resistance. The oil curve begins to rise at a considerably lower temperature than that of the boiling water, but falls nearly parallel with it.

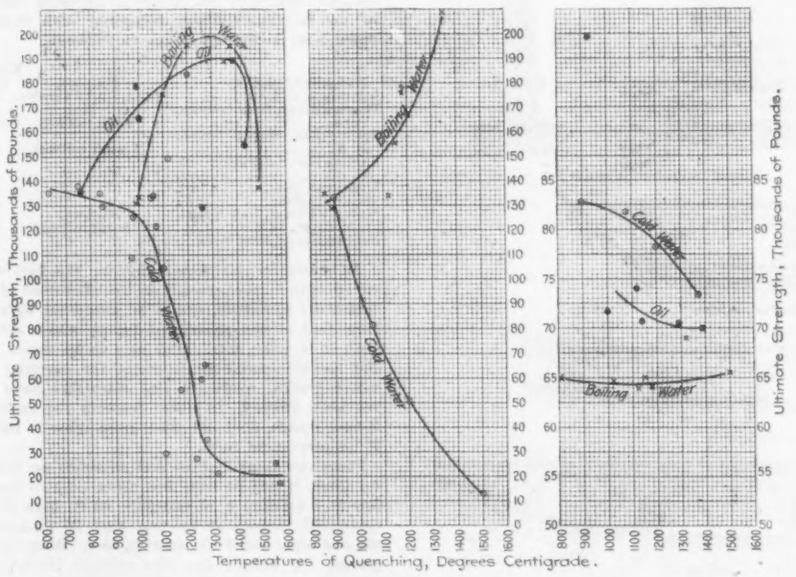
By trials with a file, the hardness of steel quenched in either oil or boiling water was found to be less than that hardened with cold water; in fact, the pieces quenched at high temperatures in boiling water were comparatively quite soft.

The next tests are of the "Black Diamond" tool steel of Park Bros. & Co., having carbon about 1%; mean ultimate resistance of untempered pieces, 138,000 lbs. per sq. in.; mean elastic limit, 67,000 lbs

The next tests are those of the low Bessemer steel; carbon about 0.18%; mean ultimate resistance for the untempered pieces, 61,000 lbs.; elastic limit, 38,000 lbs. per sq. in.; mean reduction of area, 64.5%. In the diagram the cold water gives the greatest ultimate resistance, and the table shows the elastic limit to be also greater; but the reduction of area, which would correspond to stretch, is reduced.

For boiling water the curve shows quite uniform results between 800° and 1,200° C.; and from 1,300° to 1,500° C. the ultimate resistance, elastic limit and reduction of area are all increased. The pieces quenched in oil at a temperature of about 1,300° C. give the best results.

In conclusion, from these tests, for tool steel cold water gives greater hardness than either oil or boiling water, but the steel should not be heated beyond 900° or 1,000° C., "cherry red." For structural steel cold water is not suitable for a quenching bath. Either oil or boiling water as a quenching bath gives the best results when the steel is quenched at about 1,300° C., "bright orange" color, which is considerably above "cherry red," the color generally supposed to give the best results.



Howe, Brown & Co.'s Tool Steel. Park Bros. & Co.'s Tool Steel. Troy Steel & Iron Co.'s Bessemer Steel.

DIAGRAM SHOWING RESULTS OF EXPERIMENTS TO DETERMINE THE EFFECT OF HARDENING ON THE ULTIMATE STRENGTH OF STEEL.

In tool steel, oil or boiling water does not harden steel to the extent that cold water does, but it gives the greatest ultimate resistance and elastic limit, and for a certain class of tools it is better. In structural steel boiling water gives good uniform results and improves the steel; but oil gives the best results, and it appears that it is possible to improve structural steel very much by quenching it in oil. Although there are not enough tests made in this case to make it certain, yet it seems from the inspection of the table that the elastic limit increases with the temperature of the steel at quenching, especially when quenched in oil or boiling water.

MASONRY ARCHES ON THE STANISLAU-WORONIENKA RY., GALICIA.

By John C. Trautwine, Jr., Assoc. Am. Soc. C. E.

"The bridges of the Stanislau-Woronienka division of the Stanislau-Marmaros-Szigeth line of the Austrian state railways," says Ober-Inspector Ludwig Huss,* "owe their existence solely to a combination of favorable conditions, partly personal, partly impersonal, in their nature." What these conditions were we are soon permitted to see.

As to the natural conditions, we note that the division in question, 58 miles long and now under construction, lies in Galicia, upon the northeastern slope of the Carpathian Mountains, and follows for 29 miles the deep, narrow and rocky valley of the Pruth, where "the mountains consist of an old and durable sandstone, in massive and nearly vertical strata, with many slopes covered with magnificent blocks, the relics of ancient landslides." The rock in the bed of the river is everywhere exposed, and, owing to the torrential character of the stream the stones forming its debris are generally larger than the fist.

For the personal considerations we turn to the "k. k. General-Direction der Oesterreichischen Staatsbahnen." This august body, we are informed, had indicated its desire that the use of iron bridges should, as occasion offered, be abandoned in favor of stone arches; and not unnaturally the engineers at once recognized, on the first inspection of the Pruth Valley, in May, 1891, that here was a grand opportunity for carrying these instructions into effect.

Given four crossings of the deep and narrow valley of the Pruth, hewn in the rock and abounding not only in broken stone of dimensions to suit, but also in timber for the centers—given, above all, instructions from a "k. k. General-Direction" to avoid iron and build stone bridges, and we have no difficulty in understanding Inspector Huss' reference to "a combination of favorable conditions, as well personal as impersonal."

The bridges of the four Pruth crossings are shown in the accompanying cuts. Of the former, that at Jaremcze, with its 65 m. (213 ft.) span, is believed to exceed, in this respect, any other railway bridge in the world, and the only existing stone bridge of any kind the span of which equals or surpasses it is the Cabin John aqueduct bridge at Washington, completed in 1859, with a 220-ft. span (Eng. News, June 25, 1887). Of course, we except the mammoth span of 72.25 m. (237 ft.) which is said to have been thrown across the Adda, at Trezzo, in Italy, in the latter half of the 14th century, and to have been destroyed by Carmagnola in 1416, leaving only the remains of the two abutments, which are still standing.

Inspector Huss also compares his great Pruth span of 65 m. with the French railway bridges, the Pont de Lavaur (61.5 m.) and the Viaduct du Gour-Noir (60 m.) (Eng. News, Aug. 18, 1892), but omits to mention the beautiful Grosvenor bridge of 200-ft. (61-m.) span, built by Hartley in 1833, over the River Dee, at Chester, England.

As will be seen by comparing the elevations of the four bridges over the Pruth, these are generally similar in design, consisting of a single large segmental arch (in one case semi-circular), which spans the entire width of the stream and is surmounted by six or eight small spandrel arches carrying the roadway, while the approaches are carried by arches of from 9 to 12 m. span, carried by tall piers.

The rise of the Jaremcze arch is not shown in the original drawing or stated in the text, but as nearly as it can be scaled from so small a sketch it measures 18 m., or 59 ft., which gives a radius of 126 ft.

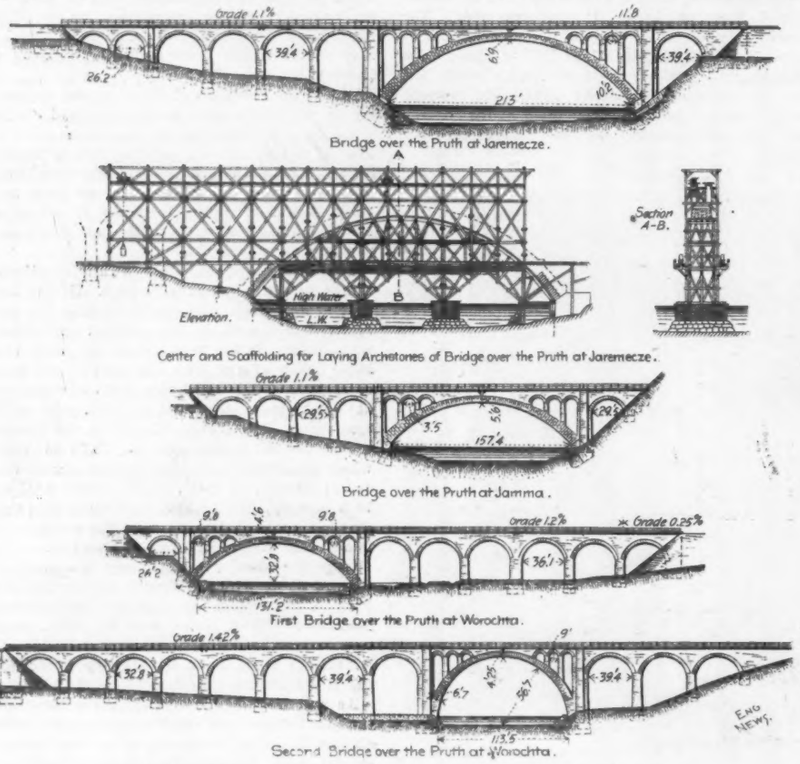
These Pruth bridges are but 4.5 m. (14.7 ft.) wide, being built for single track only. Owing to the exceptionally favorable conditions (of impersonal nature) afforded by the site, they cost less than iron trusses, and they have, of course, in addition to other advantages, this important one, that, owing to their great weight, relatively to that of any possible moving load, there is no likelihood that the increase always going on in the weights of rolling stock will in any reasonable time require their reconstruction, as it undoubtedly would if these bridges were of iron.

Notwithstanding the excellent character of the stone furnished by the locality, care was taken (apparently by providing greater areas of cross-section) to subject the material to lower unit pressures than those usual in stone bridges. As an illustration of this, these Galician arches are compared, in the accompanying table, with the two French arches of Gour Noir and Ceret. The strains given are those obtained by the elastic theory, The table gives also the spans and the arch thicknesses of these bridges, and the total costs of those now under consideration.

* "Zeitschrift des Oesterreichhischen Ingenieur- und Architekten Vereines," Oct. 20, 1893.

For such of these arches as exceeded 40 m. (131.2 ft.) in span, cutstone was employed; for arches from 15 to 40 m. (49.2 to 131.2 ft.), rough coursed work; and for smaller arches a rubble of flat stones. The mortar was composed of 1 part Portland cement, from Szczakowa (in Galicia), and 3½ parts sand. In order to avoid excessive loading of the centers during the erection of the larger arches, the innermost ring was first built entire, and the second ring was not begun until from two to three weeks later. It was then commenced in at least four different places between the skewbacks, so that the closing of the ring took place simultaneously at not less than three points. This plan was, in fact, followed in all the arches of greater span than 16 m. (52.5 ft.).

Why there should have been any hesitancy about



MASONRY ARCH BRIDGES, STANISLAU-WORONIENKA RY., GALICIA.

undertaking even the great arch of 213 ft. at Jaremcze under the magnificently exceptional natural conditions there prevailing, and with the examples of the Grosvenor bridge (200-ft. span, 1833) and of the Cabin John (220-ft., 1859), before—or rather behind—the engineers, is not explained; but Inspector Huss declares that the advisability of such an undertaking would have appeared very doubtful if it had not been that the results of the experiments of the "Gewoelbe Comite" (Committee on Arches) of the Oesterreichischer Ingenieur-und Architekten-Verein (Austrian Society of Engineers and Architects) had not demonstrated that the theory of the elastic curve is entirely applicable to stone arches. Seldom, perhaps, have the results of a scientific investigation been so promptly accepted and so unhesitatingly acted upon in the construction of very large works, as were those of this committee, which, appointed early in 1890, was charged with the duty of "undertaking tests for the gathering of experimental results respecting the degree of safety of arch construction, as well as regards the safe loads of the several materials used in such construction."

The work of the committee was divided into three branches, viz.: 1. Investigations as to the strength and elasticity of the materials used in arch construction; 2. experiments as to the breaking loads of the commoner forms of small arches used in floors; and, 3. experiments as to the breaking loads of arches of greater span and of iron arches. The objects experimented upon under 2 comprised six arches of 1.35-m. (4.43-ft.) span, six of 2.70-m. (8.86-ft.) and two of 4.05-m. (18.28-ft.), all 2-m. (6.56-ft.) wide. Under 3 were included five arches, each of 23-m. (75.4-ft.) span, 2-m. (6.56-ft.) wide, 4.6-m. (15.1-ft.) rise and 2-m. (6.56-ft.) wide, two of which were of concrete of different constructions, one of rubble, one of brick and one of cut stone.

The results of these investigations were found to justify the application of the theory of the elastic arch to arches of masonry, whereupon these great bridges, one of which has a span of 213 ft., were forthwith designed and proportioned in accordance with that theory, forming, as Inspector Huss remarks in his description of them, the first fruit of the experiments made by the Austrian society, a fruit of which that society may well be proud.

We are not told in what particulars and to what extent, if any, this discovery of the "Gewoelbe Comite" affected the design of these arches, and a comparison of the elevations of these Galician bridges with that, for instance, of the Viaduc du Guor Noir, fails to develop any very radical departures in design. The inspector takes occasion to state the probability that in the very near future these great arches will be thrown into the shade by still greater works of the same kind.

Dimensions of Six Galician Bridges Compared with Gour Noir Viaduct and Cèret Bridge, France.

	Span.		Thickness at key.		Thickness at spring.		Max. unit pressure.*		
	Ft.	Mtrs.	Ft.	Mtrs.	Ft.	Mtrs.	Kg. per sq. cm.	Lbs. per sq. ft.	Total cost,†
Jaremcze Bridge	213.2	65.	6.89	2.1	10.2	3.1	27.5	56,320	$31,888
Jamna "	157.4	48.	5.6	1.7	8.5	2.6	25.1	51,405	18,868
First Worochta Bridge	131.2	40.	4.6	1.4	7.2	2.2	21 4	43,827	14.632
Second " "	113.5	34.6	4.25	1.3	6.7	2.05	17.6	36,044	16,432
Uzeniec Bridge	72.2	22.	2.6	0.8	4 3	1.3	19.8	40,580	7,140
‡ Tablonica Bridge	82.	25.	3.6	1.1	5 2	1.6	18	36,864	6,064
Viaduc du Gour Noir	196.8	60.	5.58	1.7	13.8	4.2	30.4	62,259	.....
Pont du Cèret	147.6	45.	4.59	1.4	13.1	4.	27.	55,296	.....

* No tension exists in any of the six Galician bridges.
† The value of the florin is taken at 40 cts.
‡ These two bridges are on the same line of railway, but are not illustrated.

THE 520-FT. SWING SPAN, INTERSTATE BRIDGE, OMAHA, NEB.

(With inset.)

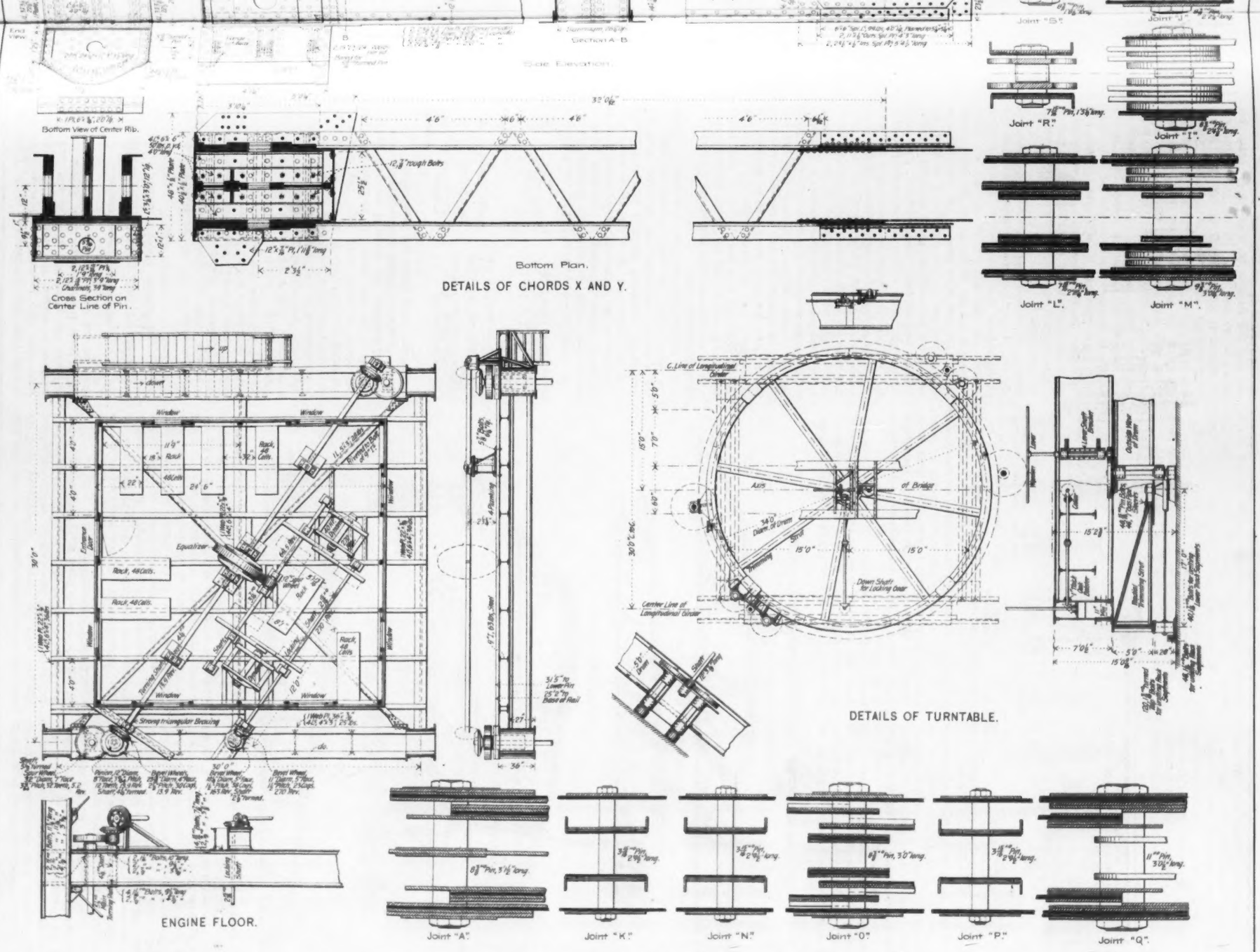
In our issue of Nov. 23 we illustrated and described in detail the construction of the pivot pier of the Interstate Bridge, now being constructed between East Omaha, Neb., and Council Bluffs, Ia., by the Omaha Bridge & Terminal Ry. Co., and we give this week full illustrations of the steel trusses and the turning machinery of the 520-ft. swing span. This is the largest and with one exception the heaviest swing span in the world, it being exceeded in weight only by the four-tracked, solid-floor swing span being built by the New York Central & Hudson River R. R. Co., over the Harlem River, in New York city. The respective weights of the two spans will be about 3,000,000 lbs., and 4,400,000 lbs. Some of the main features of the Interstate Bridge compared with those of other large swing spans are as follows:

Name and location.	Purpose.	Length. feet.
Interstate, Omaha, Neb.	2 tr'k Ry.; 2 r'dw'ys.	520
Thames River, New London, Conn.	2 tr'k railway	503
Arthur Kill, Staten Island, N. Y.	1 track railway	500
Raritan River, Long Branch R. R.	" "	472
Louisiana, Mo.	" "	446
Winona, Minn.	2 " "	440
Macomb's Dam, New York	Highway	412
Ft. Madison, Wis	1 track railway	401
Harlem River, New York	4 " "	389

As stated in our former article, the Interstate swing span is now erected on the alinement of the temporary structure, which is somewhat different from that of the permanent bridge which will be built at a later date. It is also to be noted that the outside cantilever brackets for carrying the motor tracks, roadways and sidewalks have not yet been erected. In other respects the span, as it now stands, does not differ from what it will be in its permanent form.

From the general plans and elevation on the inset sheet, it will be seen that there are two trusses 520 ft. long c. to c. of end pins, 95 ft. high at the center, 95 ft. high at the first hips, 25 ft. high at the end hips, and 30 ft. apart c. to c. Between the trusses are carried the two railway tracks, and on the outside cantilever brackets are the two motor tracks, roadways and the sidewalks, all being at the same level. Each truss consists of two parts linked to the center tower resting on the turntable. The loads for which the bridge is calculated are as follows: A live load consisting of the train load (which is Waddell's standard engine loading Class X.), and 100 lbs. per sq. ft. of roadways and sidewalks. This load is used in computing the floor systems and primary truss members. The webs and chords are computed for a live load assumed at 9,600 per lin. ft., one arm loaded, or 8,000 lbs. per lin. ft., both arms loaded. The wind pressure is taken at 600 lbs. per lin. ft. for the lower lateral system, and 280 lbs. per lin. ft. for the upper lateral system. The dead load is assumed at 6,100 lbs. per lin. ft. The strains, composition and sections of the various members are clearly shown by the drawings.

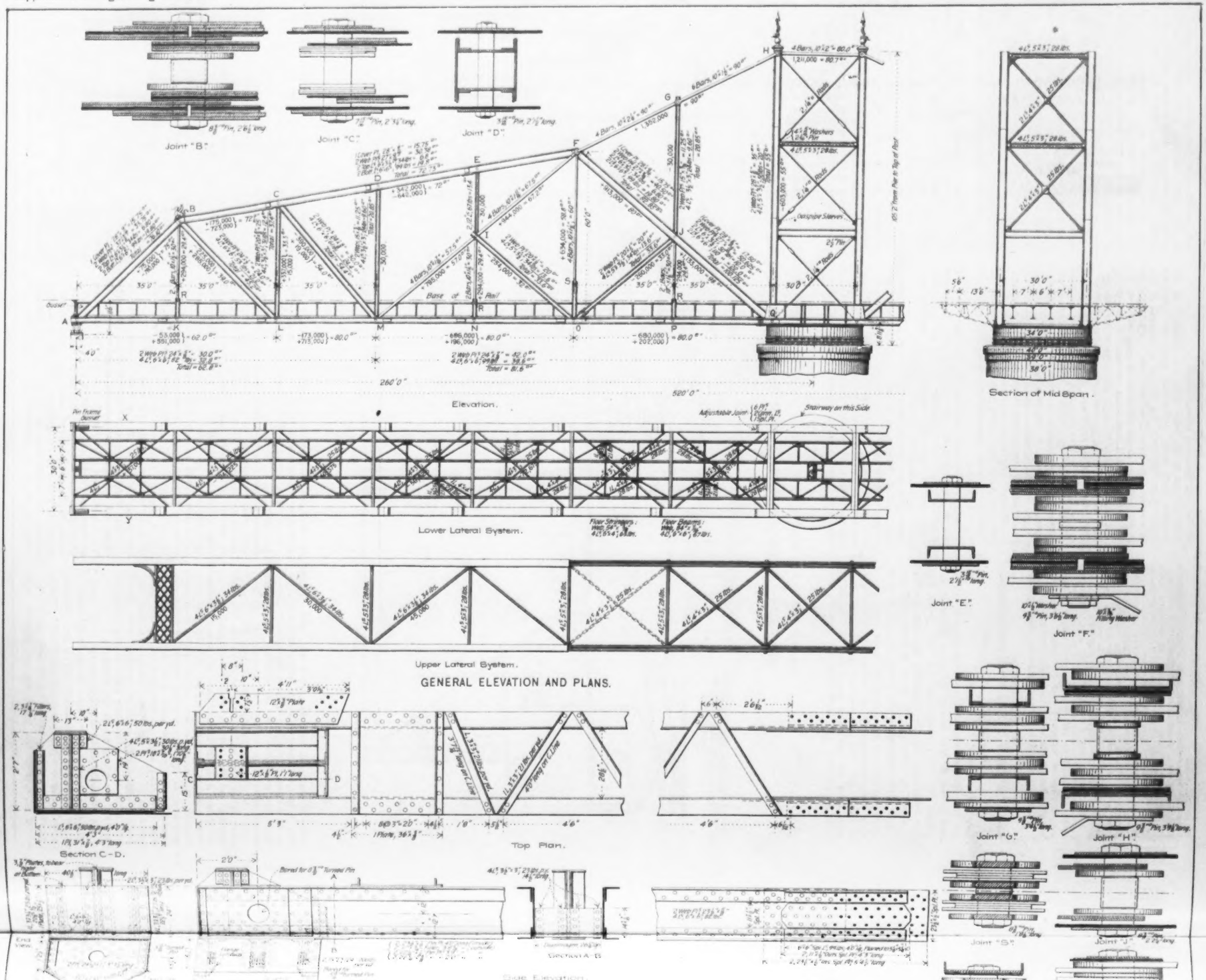
The bridge is operated by two 40-HP. Waddell-Entz motors capable of running at 270 revolutions per minute, placed on the floor of the engine-room on the first horizontal tower girders. A plan and sections of this floor are shown on the inset sheet. For turning the bridge the motors gear with a horizontal shaft which in turn gears with an equalizer on a second horizontal shaft which gears at its ends with the vertical shafts to the drum. For lifting the ends the motors gear on the opposite side with a horizontal shaft which in turn gears with the vertical shaft to the drum. The arrangement of the machinery at the drum is also shown on the inset sheet. It will be seen that the end lifts are operated by a horizontal shaft running lengthwise of the span and operating a screw



520-FT. SWING SPAN, INTERSTATE BRIDGE, OMAHA, NEB.

Chief Engineer, J. A. L. Waddell, M. Am. Soc. C. E. Contractors, Phoenix Bridge Co.; John Sterling Deans, M. Am. Soc. C. E., Engineer.

CHAS. HART & SONS, LITH., 88 VESEY ST., N. Y.

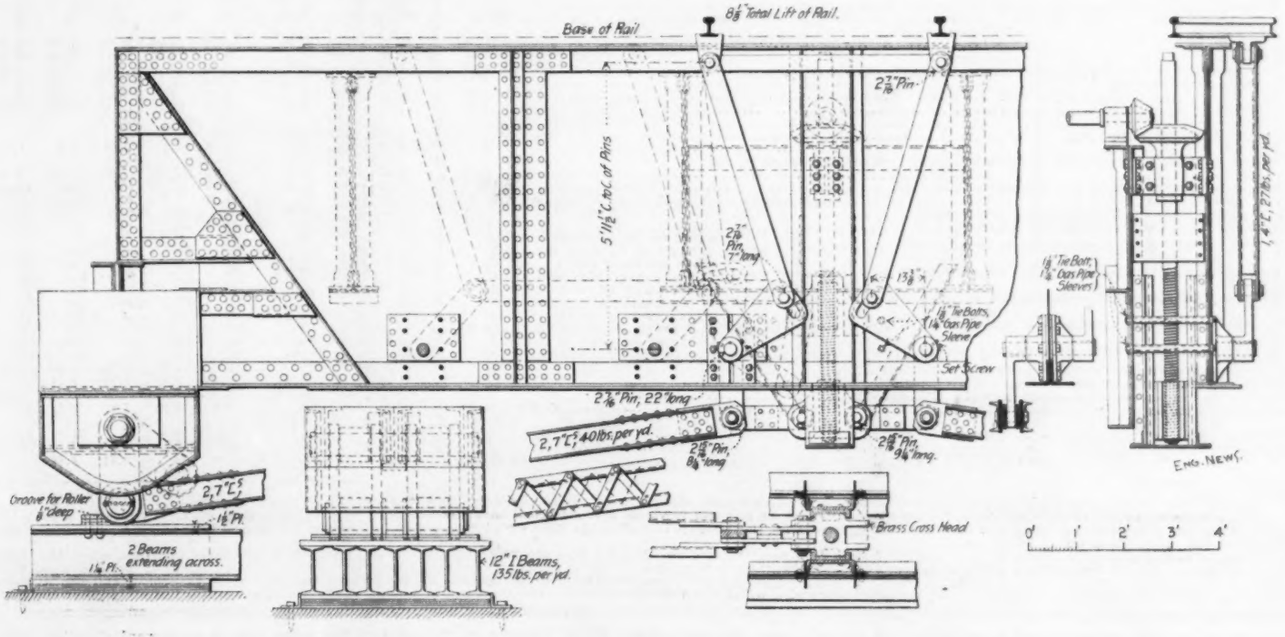

Joint "B".
Joint "C".
Joint "D".
Elevation.
260'0"
520'0"
Section of Mid Span.
Lower Lateral System.
Joint "E".
Joint "F".
Upper Lateral System.
GENERAL ELEVATION AND PLANS.
Joint "G".
Joint "H".
Section C-D.
Top Plan.
Joint "S".
Joint "J".
Section A-B
Side Elevation.

which lifts both the rails and the locking pins through a series of levers. This end lifting machinery is shown in the accompanying cut. Details of the lower end panel chords and of the different joint packings are also shown on the inset sheet.

The following is an abstract of the main provisions of the specifications for material:

All metal is to be medium steel, except adjustable members, which are to be of wrought iron; rivets, which are to be of soft steel; and the cast steel portions. All steel shall be manufactured by the open hearth process, and no other kind shall be used. It shall have an ultimate strength, except in rivets and castings, of 64,000 lbs. per sq. in. Rivet steel shall have a tensile strength of 57,000. For medium steel the elastic limit shall be at least one-half the tensile strength, the per cent. of elongation 1,200,000 lbs. divided by the unit tensile strength in pounds and a reduction of area of 2,400,000 lbs. divided by the unit tensile strength in pounds. In determining the ductility, the elongation shall be measured by breaking on an original length of ten times the shortest dimension of the test piece, in which length must occur the curve of reduction from stretch on both sides of the point of fracture. For rivet steel the limit of elasticity must not fall below 30,000 lbs., the elongation in 8 ins., 25%, and the reduction of area 45%. Rivet steel must be capable of bending double, flat, without sign of fracture on the convex side of the bend.

The chief engineer of the bridge was Mr. J. A. L. Waddell, M. Am. Soc. C. E., of Kansas City, Mo. The contractor for the ironwork was the Phoenix Bridge Co., of Phoenixville, Pa., Mr. John Stirling Deans, M. Am. Soc. C. E., Chief Engineer, and for the electric motors the Waddell-Entz Co., of Bridgeport, Conn.


Base of Rail
8⅛" Total Lift of Rail.
2 7/16" Pin.
5'11½" C. to C. of Pins
2⅞" Pin 7" long
13⅛"
1¼" Tie Bolts (1⅛" Cast Pipe Sleeve)
Set Screw
2 7/16" Pin, 22" long
2,7"L's, 40 lbs. per yd.
2⅞" Pin, 8⅛" long
2⅞" Pin, 9¼" long.
Groove for Roller 8" deep
2,7"L's
1½" Pl.
2 Beams 1¼ Pl. extending across.
12" I Beams, 135 lbs. per yd.
Brass Cross Head
1¼" Tie Bolt, 1⅛" Cast Pipe Sleeves
1,4"C, 27 lbs. per yd.
Engs. News
0' 1' 2' 3' 4'

END LOCKING MACHINERY FOR 520-FT. SWING SPAN, INTERSTATE BRIDGE, OMAHA, NEB.

Chief Engineer, J. A. L. Waddell, M. A. Soc. C. E. Contractors, Phœnix Bridge Co., Phœnixville, Pa.

RESULTS OF A NINE-YEARS EXPERIMENT ON BELTING.*

While foreman of a machine shop, the tools of which were frequently driven to their maximum capacity, the writer became convinced that the belts, which were laced according to the ordinary rules, were a great source of loss to the company—not so much from the cost of the belting and the labor of lacing as from the incidental delays to the machines, and the diminished output of the shop resulting therefrom. This was particularly emphasized when piecework rates were established, requiring the machines to be driven hard and continuously. The belting was then shown to be by far the largest source of trouble in the shop.

In 1883 and 1884 the writer superintended the design and erection of a new machine shop, in which many of the machines from an old shop were used.

As a result of experience in the old shop, the tight and loose pulleys on the countershafts were made much larger in diameter and of wider face, so that the belt power from main line to countershafting was made about 2½ times as great as formely. All belts were made endless by splicing, glueing and pegging, instead of lacing or hooking, and double belts were used throughout the shop. It was found impracticable in most cases to alter the driving pulleys from the countershaft to the machine, since generally cone pulleys were used.

In all cases the countershafts were mounted on independent frames, which could be raised and lowered in tightening the belts by the interposition of wooden packing pieces of varying thickness between the frames and the supporting stringers overhead. For this purpose standard packing pieces, varying by ⅛ in. in thickness, were always kept in the toolroom. With this method of tightening it was seldom necessary to resplice a belt, since 6 to 10 ins. of stretch could be taken up in the belt by gradually raising the countershaft, before resplicing became necessary.

Belt clamps were used having spring balances between the two pairs of clamps, so that the exact tension to which the belt was subjected was accurately weighed when the belt was first put on and each time it was tightened.

Experience soon demonstrated about the length of time that each belt would run without requiring to be tightened, and at approximately regular periods the spring balance belt clamps were put on to each belt and the tension of same weighed, and the countershaft raised just enough to maintain the belt at its proper tension. For this reason, it was a matter of very rare occurrence that a belt slipped during working hours. And as the belts were generally tightened on Sundays (the shop working night and day), the minimum of delay was caused on the machines from this source.

In case a belt slipped while the machine was in use, the man running it was never allowed to take it up. It was reported to the foreman, and one man—as far as possible—took care of all the belts. He received his orders from and made his returns in writing to the machine shop clerk, concerning time and materials used, tension of the belts, kind and condition of the splices, and nature of repairs made.

The tension under which each belt was spliced was carefully figured so as to place it under an initial strain—while the belt was at rest immediately after tightening—of 71 lbs. per in. of width of double belts. This is equivalent, in the case of oak tanned and fulled belts, to 192 lbs. per sq. in. section; oak tanned not fulled belts, 229 lbs.; semi-rawhide belts, 253 lbs.; rawhide belts, 284 lbs.

At intervals of about three months for the first two years of the test, and after this time at intervals of about five months, each belt was scraped clean, and greased with the kind of dubbing recommended by the maker of the belt.

An accurate account was kept of the original cost of each belt, and every item of expenditure, both for labor and materials used in the maintenance and care of same; also the exact stretch of each belt was recorded, and its method of treatment throughout.

Having determined upon the above method of treating the belts before building the shop, the writer concluded that this would afford an excellent opportunity for testing several types of leather belting. He therefore selected what he believed to be the four leading types of leather belts, choosing the firm with the best reputation for each type, and used the types in about equal numbers through the shop. As the shop contained a good many machines of the same kind, which were run under the same conditions, it was possible to subject the competing belts to practically the same conditions. The makers were all informed of the nature of the test which was to be made, and were given plenty of time in each case to make the best belts of their types, so that none but first-class belts of their kinds were used.

The following were the types of belts selected: 1. Oak tanned and fulled leather. 2. Oak tanned but not fulled. 3. Semi-rawhide. 4. Rawhide with surface tanned.

In considering the results of this test, it should be borne in mind that the belts called "shifting" are those running from the main line of shafting to tight and loose pulleys on the countershafts, and that these belts were used so as to have about 2½ times as great transmitting power as the ordinary belting rules would demand; while the "cone" belts, extending from the countershaft to the machine, are used according to the ordinary rules for belting.

The accompanying table gives a summary of the results of the test obtained from a study of the records. In considering these averages, it should be borne in mind that the test was begun in 1884, since which time (for about nine years) the "shifting" belts have been run on an average 20 hours per day, while the "cone" belts have not received quite such steady use, since the machines were stopped while work was put on and taken off, and they have been occasionally idle, owing to a lack of work. Still, they have cer-

* Rearranged from a paper by Fred. W. Taylor, General Manager Manufacturing & Investment Co., late Chief Engineer Midvale Steel Co. Presented at the New York meeting of the American Society of Mechanical Engineers. The experiment described was made in the machine shop of the Midvale Steel Co., of Philadelphia, beginning in 1884 and lasting until 1893. During the first six years the experiment was under the direction of the writer, while he successively occupied the position of foreman of machine shop, master mechanic, head of the drafting room, and chief engineer, after which time it was carefully conducted by his successor.

tainly been used much more steadily than those in the average machine shop.

The writer in this paper frequently uses the expression, "the ordinary rules of belting." A glance at "The Use of Belting," a book in which Mr. John H. Cooper has carefully compiled all of the belting rules established by the best authorities abroad and in this country, shows us that these rules present a wide range of difference, the ratio of divergence between the lightest and heaviest rules being as 1 to 4. By the expression "the ordinary rules of belting" we refer to a mean of these various rules, which gives a double belt a pulling power of 65 lbs. per in. of width,

A NEW FORM OF PRONY BRAKE.*

By R. C. Carpenter, Professor of Experimental Engineering Sibley College, Cornell University.

The form of brake described in the following paper was designed by the writer about two years ago, and three brakes, each of about 60 HP. capacity, have been in use on the experimental engine of the Sibley College laboratories for a considerable portion of that time. The brake consists, in each case, of a tube of copper with an elliptical section, which nearly encircles the brake wheel. Outside the copper tube is an adjustable band or belt of sheet steel which prevents the enced on long runs from heat or irregular friction of the brake. Another merit, which in some cases may be of little moment, but which was of considerable importance at the time of its erection, was the fact that the first cost was small, the brakes not costing over $50 each.

Prof. C. W. Scribner has designed a self-regulating device which I consider of great merit, but which, because of pressure of other work, has not yet been applied to the brakes just described. So far as the writer knows, every previous device for automatic regulation of the work absorbed by a brake requires the rotation of the wheel to be such as to tend to move the free

SUMMARY OF RESULTS OF NINE YEARS' EXPERIMENT IN LEATHER BELTING.

	Shifting belts.					Cone belts.				
	Oak tanned and fulled.	Oak tanned not fulled.	Semi-rawhide.	Rawhide.	Average of all shifting belts.	Average of all cone belts.	Oak tanned and fulled.	Oak tanned not fulled.	Semi-rawhide.	Rawhide.
Ave. length of belts, ft	49		50	51	50	29	30	28	29	30
" width, ins	5		5	4.50	4.84	3 8	3.82	3.31	4.5	3.75
" thickness, ins	0.37		0.28	0.25	0.31	0.31	0.37	0.31	0.28	0.25
" speed, ft. per minute					1,140	580				
Belts still in use after nine years (20 hrs. per day), per cent	All*		All	80	93.33*	27*	57	None	25	20
" worn out in nine years, per cent	None		None	20	6.66	73	43	All	75	80
Average cost, dollars, of:										
Belts when new, each	36.44		46.17	43.53	40.16	18.04	16 34	13.53	22.42	21.88
Cleaning, greasing, tightening and repairing	9.80		14.66	14.86	12.23	27	24.27	19.18	31.18	36.05
Ratio of care and maintenance to first cost, per cent	0.27		0.31	0.34	0.30 4	1.50	1.49	1.42	1.39	1.65
Cleaning and greasing	4.41		4.50	3.74	4.24	2.56	2 68	2.64	2 41	2.40
Tightening	1.90		2.31	2.69	2.24	4.64	4.31	3.51	5.23	5.83
Repairing	3 37		7.81	8.42	5.75	19.88	17.27	13.03	23.53	27.90
Belt grease					10 cents per belt per year					
Belt glue					13 cents per belt per year					
Ave. life of belts, years	9		9	8¼	8.8*	6.7†	7.2	5.5†	8.5†	5.8†
Ave. cost per belt per year of service, including first cost and maintenance, dollars	5.13		6.76	6 87	5.70	6.72	5 64	5.95	6.30	9.98
Ratio of ave. yearly cost to first cost, per cent	14%		14.6%	15.8%	14.2%	37.3%	34.2%	44%	28%	45.4%
Total stretch of belt, ins	11.9		16.9	17.3	15‡	21.4‡	16.7	21	21.4	28
Ratio of total stretch to total length of belt, per cent	.02		.02.8	.02.7	.02.3‡	.06‡	.04.6	.06.2	.06.6	07.8
Ave. number of times each belt was tightened	2.66		3	3.6	3‡	14.5‡	12	12	16	20
Tension to which belts were strained when tightened { Lbs. per in. of width	71		71	71	71	71	71	71	71	71
" per sq. in. of section	192		253	284	239	239	192	229	253	284
Ave. tension to which belts had fallen when tightened { Lbs. per in. of width	22.7		21.5	19.3	21.1	32.9	37.6	30	29.6	34.3
" per sq. in. of section	61		77	77	68	106	102	97	106	133
Ave. net (estimated) working load of belt { Lbs. per in. of width	26		26	26	26	65	65	65	65	65
" per sq. in. of section	70		93	104	84	210	175	210	232	260
Est. ave. tension of belt, exclusive of working load { Lbs. per in. of width	26.5		26.5	28.5	28	46	49	44	43	47
" per sq. in. of section	86.4		95	114	99	151	133	142	154	188
Est. ave. total load on belt (working load + tension) { Lbs per in. of width	58		52.5	54.5	54	111	114	109	108	102
" per. sq. in. of section	157		188	218	174	358	308	351	385	408
Ave. number of months from one tightening to the next	32		12.9	21	22	2.52	4.41	1.30	1.66	2.71
Ave. stretch between tightenings, ins	4.48		5 31	5.56	5.11	1.55	1.52	1.82	1.43	1.45
Ratio of stretch between tightenings to total length, per cent	0.73%		0.83%	0.87%	0.81%	0.47%	0.41%	0.61%	0.46%	0.47%
Ave. stretch per belt in first six months, ins	None recorded.		3.2	3.3	2.2	7.8	3.08	7.8	6.7	14
Per cent. of total stretch occurring in first six months			19	19	14.6‡	36‡	18.4	37	31	50.6
Ave. number of times each belt was tightened or repaired	5.5		9.27	10	6.6	32	29	26	37	40
" " " per year each belt was tightened or repaired	0.6 times	Too few of this style of belts were used to make up a proper average.	1.03	1.18	0.75	5 times†	4	4.7†	4.4†	7†

* An examination of the shifting belts still in use shows them to be practically about as good as new, while the cone belts still in use are nearly worn out.

† Among the cone belts, two oak tanned not fulled, five semi-rawhide and one rawhide belt stretched unevenly, and were returned to their makers a few months after being put into use, and these were not taken into consideration in computing the average life, although they were considered in computing the p. c. of belts still in use. None of the oak tanned and fulled belts stretched unevenly.

‡ I do not consider the data regarding total stretch of cone belts as at all reliable. For the first few years the records of stretch were accurately kept, but when the belts began to require repairs this portion of the record was carelessly kept, since frequently the belts were tightened at the same time that they were repaired; the total stretch of the cone belts certainly exceeded that given in the table. The data regarding the average stretch between tightenings, the ratio of that stretch to the length, and the average stretch in the first six months are reliable, as only instances concerning which there was no question were considered in making up the averages.

and places the most economical belt speed at between 5,000 and 6,000 ft. per minute.

When pulleys upon which belts are tightened are at rest, both strands of the belt (the upper and lower) are under the same stress per inch of width. By "tension," "initial tension" or "tension while at rest" we mean the stress per inch of width, or square inch of section, to which one of the strands of the belt is tightened, when at rest. After the belts are in motion and transmitting power, the stress on the slack side, or strand, of the belt becomes less, while that on the tight side —or the side which does the pulling—becomes greater, than when the belt was at rest. By the term "total load," we mean the total stress per inch of width, or square inch of section, on the tight side of belt while in motion.

The difference between the stress on the tight side of the belt and its slack side while in motion represents the effective force or pull which is transmitted from one pulley to another. By the terms "working load," "net working load" or "effective pull" we mean the difference in the tension of the tight and slack sides of the belt per inch of width, or square inch section, while in motion, or the net effective force that is transmitted from one pulley to another per inch of width or square inch of section.

In examining the summary given in the following table, it is to be remembered that shifting belts were so used as to be subject to a net working load only four-tenths as great as that of the cone belts. Each style of belt was, however, tightened repeatedly to the same tension, 71 lbs. per in. of width. All belts were double leather. The cone belts were supposed to give an effective pull on the pulley of 65 lbs. per in. of width, and the shifting belts 26 lbs.

Originally about 50 belts were started in this experiment, but only 42 were found available for making up the averages.

(To be continued.)

copper tube from expanding. Water pressure is applied to the copper tube by means of hose connections made near the center of the wheel to water pipes; the amount of pressure being regulated by throttling the admission and discharge valves. As the external diameter of the copper tube cannot change, the internal pressure causes the inner surface to rub against the

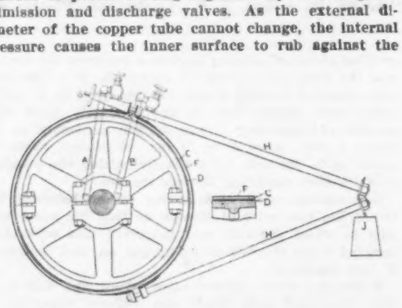


Fig. 1. A New Form of Prony Brake.

A, supply pipe; B, discharge pipe; C, brake; D, sheet iron liner; F, external sheet iron strap; G, adjusting bolts in strap; H, arms of brake riveted to strap; J, support for brake arms to be carried on platform of weighing scale.

wheel, producing the friction which is used to absorb the work. To prevent the wearing of the inner surface of the copper tube, a thin sheet of steel or Russia iron is inserted between the tube and the brake wheel, and connected to the brake so as not to revolve.

This brake has proved very satisfactory; the work is readily absorbed by varying the opening of the supply and discharge valves, and no trouble has been experi-

* A paper read at the New York meeting of the American Society of Mechanical Engineers.

end of the brake arm in an upward direction. This is oftentimes objectionable, and sometimes an element of danger. In this case Professor Scribner permits a downward motion of the brake arm, and yet succeeds in securing motion sufficient to adjust the tension on the brake.

The general method of securing the adjustment is shown in the diagram, Fig. 2, in which A C and B C

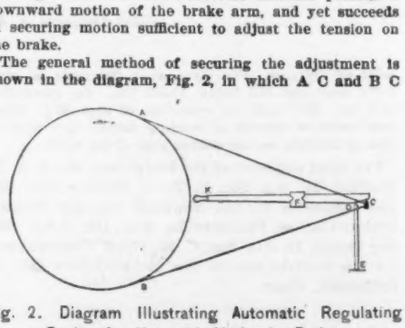


Fig. 2. Diagram Illustrating Automatic Regulating Device for Use with Hydraulic Brake.

are the brake arms; these rest on the end of a horizontal lever, K C. This lever is supported at D by a knife edge on the fixed support D E. A movable weight, F, is placed on the arm of the lever at any point needed to give the required brake load. If the load is too great, the pressure at C is greater than at F, and the point K of the lever rises; on the other hand, if the brake load is too small, the pressure at F is greater than at C, and the end K of the brake arm falls. The motion of this point can readily be utilized to decrease or increase the tension on the brake as required. In this case this motion will be utilized to regulate the opening of the supply valves and to vary the pressure on the brake. The weight F can also be utilized to weigh the load.

THE NECKAR RIVER WATER FILTRATION PLANT OF STUTTGART, GERMANY.

By Wm. P. Mason, Professor of Chemistry Rensselaer Polytechnic Institute.

The new covered filtering plant of Stuttgart, Germany, was completed in 1892 to supplement the open filters already existing. In general design the filters, both old and new, are entirely English, but the construction strikes one as being more careful than ordinary. There is no difference between the open and covered filters, except in the item of the cover, which, like all other portions of the structure, is of heavy stonework, and is supported upon columns 10 ft. apart. No ice ever forms upon the covered beds. Fig. 1 shows the plan of the old and new filter basin and all their accessories, including supply, drain and clear water pipes, the clear water basin, and, in addition, the pumping station, from which water is forced to the distributing reservoir.

The composition of the filtering bed is of the usual gradations of gravels and sands, but the thickness of the upper, or fine sand, layer is over 50% of the entire depth of bed, a deviation from common English practice. Not so much care was taken as should have been to secure uniformity in the grain of the upper sand layer, and considerable variation is manifest.

The device for registering the rate of flow from the filters, and for automatically detecting any change in the same, is entirely new for such use, although the principle has been used in the construction of small meters. As is shown by the drawing, Fig. 2 (p. 452), the purified water rises in the indicator pipe, raises the metallic disk more or less from its seat upon the lower end of the conical end piece, escapes through the annular opening thus produced, and overflows the base of the cone. Vertical movements of this disk are recorded by a simple weight and pulley indicator situated above.

Although great improvement in the water takes place through the operation of the city filtering plant, yet the river Neckar is so very filthy at the point of intake that complete purification cannot be hoped for, and the traveling public is recommended not to drink the water.

As an illustration of the efficiency of the filters, the following counts are given of the number of bacteria per cubic centimeter in the unfiltered and filtered water:

	Aug.	Sept.	Oct.	Nov.	Dec.
Unfiltered	8,042	1,310	918	2,712	3,462
Filtered	16	52	54	517	53
Per ct. remaining..	0.2	3.9	5.9	19.1	1.5

In examining these figures, it would appear to be in a measure true that the percentage of purification varied inversely as the extent of original contamination, and our thoughts at once revert to the influence of "bacterial jelly" upon the upper sand layer in arresting the passage of germs.

The water is allowed to stand 3 ft. deep upon the filter bed, and the rate of filtration is 6 cu. ft., or 44.88 gallons per sq. ft. of sand surface per 24 hours, which is nearly equal to a daily rate of 2,000,000 gallons per acre. The daily city supply is about 4,220,000 gallons, of which 2,900,000 gallons is from the river and 1,320,000 gallons (also filtered) is from a lake. In addition to this, there is a small separate supply, gathered from half a dozen or more insignificant sources in the surrounding hills, and piped to public drinking fountains on the streets. This "Quellewasser" is not led into the buildings, the city hospital alone excepted.

An interesting relic of the old Stuttgart fire service is to be seen in the beautiful little artificial lake (called the "Feuersee"), situated in the upper part of the town. In former times the waters of this lake were allowed to flow down the open gutters during a fire, thus enabling the fire workers to obtain a ready supply for their buckets.

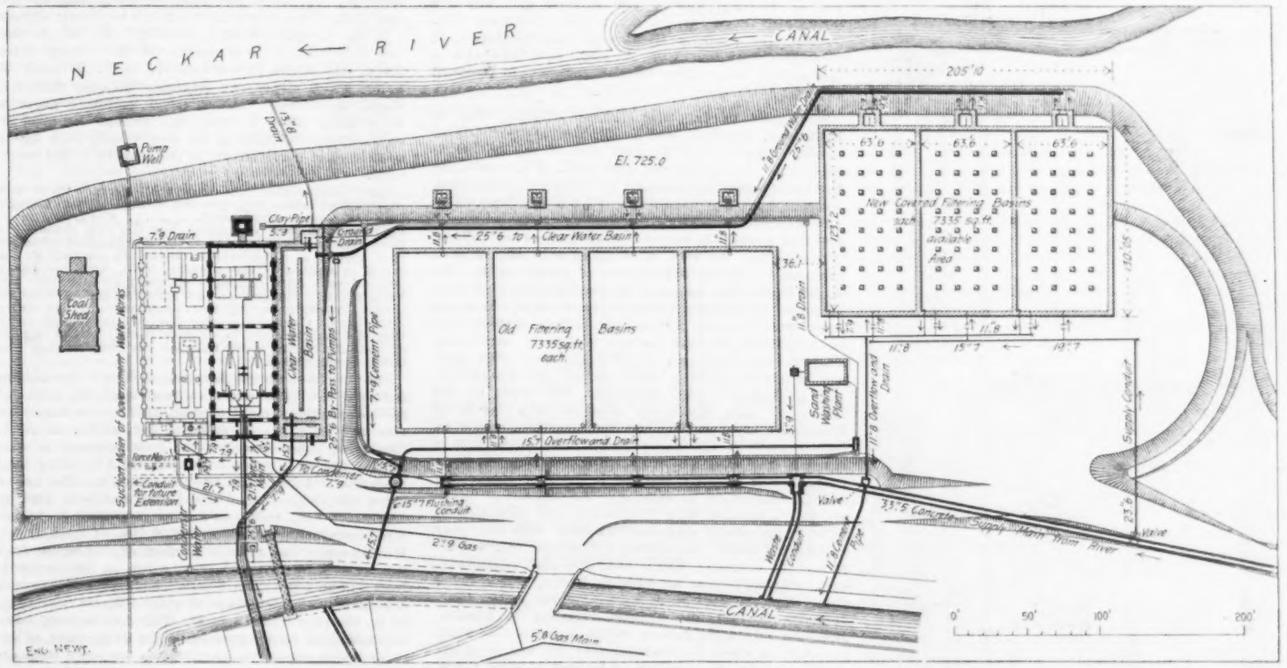


FIG. 1. PLAN OF WATER FILTRATION PLANT, STUTTGART, GERMANY.

VALUABLE TIMBERS OF NEW SOUTH WALES.

In a late issue of the Sydney "Mail" Mr. J. H. Maiden calls attention to some forest products of New South Wales, which he believes are available for export. He first directs attention to the hard woods for street paving. Jarrah is already in high favor in London and elsewhere for this purpose on account of the experience with it by the West Australian government, its well-defined uniform character and its durability. Used as railway sleepers ironbark ties cost about $1.08 each and last 20 years on the average. Mr. Maiden contrasts this timber with the average price of 78 cts. for oak ties in the United States, with an average life of seven years; or an average for all American tie timbers of 12 cts. per year for renewals. The ironbark would cost about 4½ cts. per annum for renewals and save the labor of three to six relayings.

He refers to the great value of "turpentine timber" for piles exposed to the teredo, and says that all along the Australian coast these piles have proved to be almost imperishable after many years' use. He does not further describe this timber and says that while the true secret of its durability against attack by the sea worm is not certainly known, a reasonable supposition is that it is due to a layer of a peculiar oleo-resin, popularly known as turpentine, lying just under the bark. The timber takes its name from this peculiar deposit.

For cabinet and furniture purposes, Mr. Maiden says, the values of many of the timbers of New South Wales are not yet known. But among those of well ascertained value are red cedar, rosewood and the red bean. The first serves every purpose of mahogany in the colonies, while it is only half the weight of mahogany. It has a beautiful marking and is very easily worked. The rosewood is not so handsome a timber, but has a dainty rose odor which commends it to many people. The red bean is somewhat like the rosewood, but without its odor. It has a beautiful wavy figure and pleasant color. The black bear, or Moreton Bay chestnut, is used as a substitute for American walnut and is hardly inferior to it, though in Sydney walnut costs from three to four times as much. Among other cabinet timbers are the forest oak and myall; the first having a peculiar and beautiful figure and the latter being rich in color and having a pleasant odor of violets.

Mr. Maiden gives no items of cost of producing or exporting these timbers, but says that the quantity is almost inexhaustible.

PERSONALS.

Mr. I. D. Barton, General Superintendent of the New York & New England R. R., has resigned.

Mr. A. L. Mohler has resigned his place as General Manager of the Great Northern Ry., and will be succeeded by Mr. Case, General Superintendent.

Mr. A. L. Galley, who was for some years Superintendent of Bridges and Buildings on the Chicago & Northwestern R. R., died in Chicago, Nov. 25, at the age of 53.

Mr. William C. Hudson, for ten years Secretary of the New York State Railroad Commission, has resigned, and has been succeeded by Mr. James D. McMahon, of Utica, N. Y.

Mr. R. H. Hood has resigned his position as Professor of Civil Engineering at the University of the State of Missouri, and has opened an engineering office at 12th and F Sts., Washington, D. C.

Lieut.-Col. Emiliano Corella has been appointed by President Diaz as Consulting Engineer on the part of the Mexican Government of the Boundary Commission which is to define the exact limits between the United States and Mexico along the bed of the Rio Grande.

Mr. Kenneth Torrence, M. E., has opened an office in the Monadnock Block, Chicago, for the general prac-

tice of mechanical engineering. He graduated from Stevens Institute in 1884, and has since been with Henry R. Worthington, New York, recently at the Chicago office.

Mr. Edward Martin, who died at Red Hook, N. Y., Dec. 3, at the age of 83, was for several years associated with Col. Robert L. Stevens, of Hoboken, N. J. He went West in 1835, and was engineer for a number of railways. He laid out the Hudson River R. R. from Albany as far south as Hyde Park, and at one time was Superintendent of the old Galena & Chicago Union R. R. He was the first president of the Rhinebeck & Connecticut R. R.

Mr. Paul Larsen, C. E., of F. L. Smidth & Co., of Copenhagen, is now in this country introducing a new cement product called "sand-cement." The process of

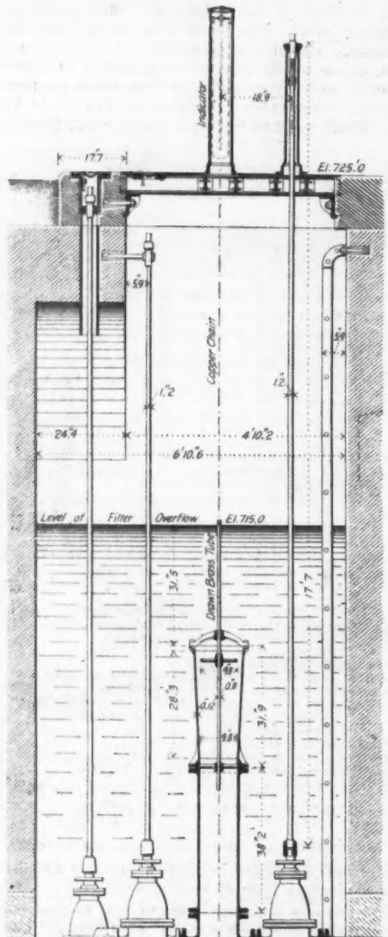


Fig. 2. Device for Registering Rate of Filtration.

manufacture is extremely simple and the principle is one easily understood. The purpose of this invention of Mr. F. L. Smidth is practically the broadening of the field of usefulness for cement-mortar, bringing it directly into competition with lime mortar for ordinary use. At an early date we expect to give full detail of what, in our judgment, is a radical advance in the preparation and use of cement-mortars.

Mr. Dion Martines, of Philadelphia, Pa., has associated himself in partnership with Mr. E. M. Wilkins, in McKeesport, Pa., the firm to be hereafter known as Wilkins & Martines, to carry on a general civil and mining engineering business. Mr. Wilkins had an office in Roanoke, Va., and was for some years Assistant Chief Engineer of the Carnegie Iron & Steel Co. Mr. Martines was for five years connected with the engineering department of the Pennsylvania R. R., and has lately returned from South America, where he held the position of topographer and assistant to Mr. Wm. F. Shunk on the First Section, Second Corps, of the intercontinenal railway surveys.

Mr. Charles Hansel has been engaged as western manager of the National Switch & Signal Co., with offices in the Monadnock Block, Chicago. He was for five years locating constructing engineer on the Denver & Rio Grande R. R., and later spent six years in the service of the Wabash R. R. He has made a special study of interlocking. In 1889 he was appointed consulting engineer to the Illinois Railroad & Warehouse Commission, continuing in that office for four years. While there he formulated standards and rules governing interlocking in Illinois, and in 1892 made a trip through Europe for the Commission, inspecting methods of signaling and interlocking.

Mr. John Bailey Denton, the famous English sanitary engineer, died at Stevenage, England, on Nov. 19. Mr. Denton was born in November, 1814, and in his earlier career was for a long time engaged with the late Mr. Brassey and Mr. Joseph Locke, past-president of the Institution of Civil Engineers, on railway work. For the last 40 years he devoted his practice to water supply and the sewerage of towns, and was one of the first advocates of sewage purification by land filtration. His writings on the subject of drainage and sewage disposal generally are recognized standards in engineering literature. Mr. Denton was made a Member of the Institution of Civil Engineers on April 5, 1842, and was also a member of many other learned societies in England and Europe.

Prof. John Tyndall, the eminent scientist, died at Haslemere, England, Dec. 4. He was born at Lighlin Bridge, Ireland, Aug. 21, 1820, and at the age of 19 became an assistant in the local work of the Ordnance Survey. In 1844 he proposed to emigrate to America, but was dissuaded by his friends, and for three years was engaged in railway engineering, after which he accepted a position as teacher at Queenwood College, in Hampshire. In 1848, in company with Mr. Edward Frankland, afterward professor of chemistry in the Royal Institution, he went to the University of Marburg, in Hesse-Cassel, where he studied chemistry under Prof. Bunsen, and it soon became evident that he had found his true sphere in life in conducting scientific investigations. Besides his work with Bunsen he studied physics with Gerling and Knoblanch, and mathematics with Stegmann. His work in the laboratory with Knoblanch resulted in a series of discoveries in magnetism and diamagnetism, which he incorporated in the paper which first made him a name in the scientific world, "On the Magneto-Optic Properties of Crystals and the Relation of Magnetism and Diamagnetism to Molecular Arrangement," written in conjunction with Knoblanch, and published in "The Philosophical Magazine" in 1850. The next year he took his degree, submitting a thesis on "Screw Surfaces" (in German), which won him high commendation. The same year he went to Berlin, where for a short time he continued his researches under Prof. Magnus. In 1851 Mr. Tyndall returned to London, and soon afterward formed the acquaintance of Prof. Faraday, to whom he communicated the results of experiments of such ingenuity as to lead at once to his election as a Fellow of the Royal Society. In 1852 he became a member of the British Association for the Advancement of Science and applied, but in vain, for a vacant professorship in the University of Toronto, Canada. The next year he was elected professor of natural philosophy in the Royal Institution and in the Government School of Mines. Prof. Tyndall made his first visit to Switzerland in 1849, and the publication of an essay on the cleavage of slate rocks was the proximate cause of his joining his friend, Prof. Huxley on a visit to the Swiss glaciers in 1856. They afterward published a joint paper on the structure and motion of glaciers. Prof. Tyndall returned to Switzerland in 1857, 1858 and 1859 and studied the winter motion of the Mer de Glace glacier. The scientific results of these excursions are seen in the four well known volumes of Alpine studies. His studies on radiant heat were begun in 1859 and culminated in the publication of his lectures at the Royal Institution in 1863, in his celebrated work entitled, "Heat Considered as a Mode of Motion." His studies on the theory at one time held of "spontaneous generation," made in 1875 and 1876, were extremely important, showing that theory to be untenable, and proving that the organisms developed in putrefaction and fermentation were due to bacteria received from the air and not spontaneously generated. In 1872, in response to a request signed by many prominent scientific and literary men of America, Prof. Tyndall visited this country and delivered 35 lectures, the net income from these lectures amounting to more than $13,000. He formed a scholarship fund, the income of which is given to scientific students in Harvard, Columbia and the University of Pennsylvania to further their studies under certain broad conditions in the universities of Europe. Prof. Tyndall's writings include many volumes and detached articles upon the most important branches of physical science. They are marked in general by a lucid and pleasing style and by a faculty of presenting the results of laborious investigations in a manner to attract the widest attention. In 1876 he married the eldest daughter of Lord Claud Hamilton. He leaves no children.

NEW PUBLICATIONS.

December Magazines.—The Christmas numbers of the literary magazines are largely given up to short stories, among which we find in "Scribner's" a very well told tale of railway life, entitled "The Semaphore." Its hero is a towerman located at an important junction, where three men work on eight-hour shifts. On account of the illness of one of the men the other two have to work 12 hours each, and at the same time the child of one of them becomes dangerously ill, and he starts in on a new shift after having been without sleep for 48 hours. The story narrates his battle to fight off sleep during a long, stormy winter's night, and how he finally prevents a collision when the home signal becomes clogged with ice and cannot be pulled to danger by hurrying out with hammer and file and breaking the connection on the signal post. The writer has evidently made quite a study of signaling, but we do not know where he gets his idea that freight trains pay no attention to distant signals.

In the "Popular Science Monthly" Mr. W. A. Dobson describes the new vessels of the United States Navy. He writes the letters M. S. N. A. after his name, which means, we suppose, "Member Society of Naval Architects"; but a naval architect ought to know better than to credit the demand for steel for constructing the hulls of our new vessels with having created steel manufacture in this country. The author says:

> This competition has indirectly opened up a new material of some 20% greater strength than wrought iron, known as weld steel. . . . Congress, in its appropriation, had stipulated that the new vessels (the four Roach vessels) were to be constructed of steel; this meant a considerable outlay in capital to the metal producers of the country, who, with the exception of some firms making a specialty of tool steel, had been mainly engaged in the manufacture of wrought iron. However, having full confidence in the determination of Congress to give the country a new navy, they did not hesitate to at once install plants capable of manufacturing steel suitable for shipbuilding and boiler construction.

The fact is of course that compared with the demand for steel for bridge and structural work, for rails and for boilers, the amount of steel used on our naval vessels has been too insignificant for notice. A nicely illustrated paper describes the fruit industry in California, and in a much more judicial tone than most magazine articles which have discussed it. The author gives the shipments of California fruits in 1891 at 387,000,000 lbs., which, as a large proportion is shipped dried, represents some 600,000,000 lbs. of fresh fruits. He estimates the average product of California fruit farms at 1,200 lbs. per acre, worth in the orchards from $12 to $40. "The Forum" announces this month a reduction of price from 50 cts. to 25 cts. per copy, or by the year from $5 to $3. This will be good news to those who have appreciated the high class of articles which appear in its columns, but have been deterred from subscribing for it on account of its high price. The table of contents for the month includes papers on political, literary, social and educational topics, and Mr. Franklin H. Head writes on "The Fair's Results to the City of Chicago."

In the "North American Review" Hon. W. E. Simonds, ex-Commissioner of Patents, defends the American patent system and its work. He would meet such abuses as exist by amending the present laws so that no innocent user of a patented article can be sued for infringement if the maker or seller can be reached, also by limiting the life of a patent to 20 years from the date the first application is filed. Col. H. G. Prout, editor of the "Railroad Gazette," compares British and American railway accident statistics, a comparison with which our readers are already familiar. Capt. Sampson, Chief of the Bureau of Ordnance, U. S. N., gives his idea of "The Battleship of the Future," which is in brief an enlarged and strengthened copy of the largest and strongest vessels now afloat.

A FIELDBOOK FOR CIVIL ENGINEERS.—By Daniel Carhart, C. E., Dean and Prof. C. E. W. Univ., Pa. Boston: Ginn & Co. Oblong 12mo; pp. 281; 90 cuts; 117 pp. tables; $2.50.

This is a fieldbook of somewhat novel type and with a good many strong points, in part due to the perfectly legitimate advantage which Professor Carhart has utilized without abusing, that of having many predecessors from which to gather suggestions both as to single problems and general methods. The one serious criticism on the book—and a very serious one—is that it does not contain even a reference to transition curves, nor to the effect of these curves to modify the usual curve formulas. A new fieldbook without this matter is certainly needlessly defective, since it need occupy no great extra space. Apart from this important omission, which it shares with all the earlier fieldbooks with which it seeks to compete, we are disposed to

regard this book, on the whole, as among the very best field manuals which exist, and as distinctly superior to some of its earlier and more elaborate predecessors, though it still remains true that it is no longer pardonable to put out a new fieldbook without treating transition curves in it.

This work is also, in our judgment, a better manual for the instruction of students than most of its predecessors, in that the student is likely to get from it a better idea of approved methods of practical fieldwork. Its shape is to be especially commended in being somewhat narrower and higher than most fieldbooks, and thus better adapted to pocket use.

The title of the book is a curious misnomer. It is not at all a general manual "for civil engineers," but solely for railway engineers. Such a misnaming is the more curious, because in the very first sentence of the preface the author points out in detail that "the work of the civil engineer is varied and extensive," and that he only proposes to cover one small corner of it, but without explaining why he took the broad title. It was, perhaps, to avoid verbal conflict with earlier titles, but this was unnecessary. Any man has the right to use a rigidly descriptive title, even if the only distinction left between his book and another's is in the name of the author.

The first two chapters of the book (28 pages) are an extremely sketchy outline of reconnaissance and preliminary survey methods, chiefly occupied with adjustments of instruments, duties of the several members of field parties, and the art of taking topography. Considering the space taken it is well done, yet considering the importance of the work thus lightly dealt with it is certainly a great oversight that there should not be even a word of caution as to its necessary defects of omission. Apparently the author himself lacks the consciousness that, in the respect of practical results, all the seriously important work of location is covered by the 28 pages which discuss it so lightly, and that the only effect of the final location work is to modify slightly the cost of construction.

The next three chapters and 68 pages on curves and curve problems are concise and good, with the one serious exception and grave fault already noted, that it contains not even an allusion to the existence of, need for, or method of using transition curves. With this exception, most of the curve problems practically useful in location work are given here, and none not so useful. The abominable excess of mathematical lumber having no semblance of utility, which defaces some fieldbooks, is here absent; and this is a great gain. The result is that in the time needed to get a confused idea of how fieldwork is not done, by "going through" some of the older fieldbooks, a comprehending familiarity with the real methods can be gained from these few pages. The work is based on the important recommendation that 100 ft. chords be used only up to 8° curves; 50 ft. chords from 8° to 16°; 25 ft. chords from 16° to 38° (which might as well be 32°), and 10 ft. chords thereafter. The simple formula 5,730 : D then gives the radius for any curve whatsoever within a small fraction of a foot.

The succeeding 28 pages are devoted to construction fieldwork, and while necessarily sketchy—extremely so—are still very good, with the sole exception that the method of end-areas with prismoidal correction, the only proper method of computing railway earthwork, is not even alluded to. The instructions for setting slope stakes are very good.

The concluding chapter on frogs and switches is by another hand, and rather fussily mathematical, but not more so than in most fieldbooks. We confess to an access of "that tired feeling" when we see a man taking several pages of a fieldbook to demonstrate that, when the main curve is pretty sharp, theory requires the lead to be an inch or two or three longer or shorter than it otherwise would be. Either his sanity or his knowledge of his subject becomes immediately questionable.

The tables are chiefly reproductions from other works. They are in the main well selected, but it is not clear why a table of logarithms of numbers should be included when the logarithms of the angular functions are not given. Still, it may have some utility and occupies little space. Radii are given for 100 ft. chords up to 20° curves, in violation of the author's own instructions, and it should be so stated.

THE MECHANICS OF HOISTING MACHINERY, Including Accumulators, Excavators and Pile Drivers. By Dr. Julius Weisbach and Prof. Gustav Herrmann. Translated from the second German edition by Karl P. Dahlstrom, M. E. London and New York: Macmillan & Co. 8vo; cloth; pp. 332; 177 illustrations; $3.75.

This volume is the translation of a small part of Professor Herrmann's edition of Dr. Weisbach's monumental work on "Mechanics," now being published in Germany, and is a welcome addition to the sections on Theoretical Mechanics, Steam Engines and Hydraulics, and Machinery of Transmission previously translated by Mr. Eckley B. Coxe and Professors Du Bois and Klein. The chief value of the book lies in the theoretical discussions of the principles and deficiencies of the various methods of applying power in hoisting, and not in the actual examples of hoisting machinery described and illustrated, most of which are obsolete and all of which are foreign in design and make. The headings of the various chapters given further on will give a very fair idea of the scope of the book. Steam power and hydraulic and pneumatic power and their application and efficiency are quite fully discussed, and considerable space is given to the description of levers, jacks, tackle and windlasses operated by hand power. Electric power, it is needless to say, is not considered.

The eight chapters into which the volume is divided are as follows: I., Levers and Jacks; II., Tackle and Differential Blocks; III., Windlasses, Winches and Lifts; IV., Hydraulic Hoists, Accumulators and Pneumatic Hoists; V., Hoisting Machinery for Mines; VI., Cranes and Shears; VII., Excavators and Dredges; VIII., Pile Drivers. As stated before, the book is of chief value for its theoretical discussions, and considering the general lack of information on the subject of hoisting machinery in so simple and compact form it should prove a useful addition to the engineer's library. The publisher's work is excellent, both in typography and engravings. The index is of little value.

SOCIETY PROCEEDINGS.

NORTH PLATTE IRRIGATION ASSOCIATION.—A general state convention will be held by the association on Dec. 19 at North Platte, Neb. J. A. Fort is president and John Hawley is secretary of the association.

ENGINEERS' CLUB OF CINCINNATI.—At the October meeting Mr. Chas. A. Ewing read a paper on "Contractors versus Specifications." He considered that contractors do not receive just recognition from the engineering profession, but are a mistreated class, and made so by the engineer through the forms of specifications and contracts imposed upon them. He suggested that a simplification of these would prove of benefit to both the engineer and the contractor.

J. F. Wilson, Secy.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—The annual meeting was opened on Monday evening, Dec. 4, at the society's house, in New York city, with an address by the President, Eckley B. Coxe. The address was devoted to a discussion of the utilization of the smaller sizes of anthracite as fuel. As a member of the Pennsylvania commission appointed to investigate the sources of waste in anthracite production, Mr. Coxe has paid great attention to this subject, and his address was listened to by a large and appreciative audience. At present, said he, the smaller sizes of anthracite are graded as follows:

Trade name of size.	Wholesale price at mines.	Limits of size. Upper.	Lower.
Chestnut	$2.75	7/8	3/4
Pea	1.25	3/4	5/8
Buckwheat	.75	5/8	3/8
Rice	.25	3/8	1/8
Barley	.10	1/8	3/32

In addition to the saving in first cost, freight rates are less on the smaller sizes. Freight to tidewater is 30 cts. a ton less on pea than on the domestic sizes, and 50 cts. less on sizes smaller than pea. The utilization of these smaller sizes is of comparatively recent date. In the early days of anthracite production all the small coal went into the culm banks. Even now the value of these smaller sizes as a cheap fuel for steam making does not begin to be appreciated, as is proved by the very low prices at which they are sold. More or less difficulty has been experienced in burning these small sizes, due to the fact that too little care has been taken in their sizing or lack of proper facilities for their burning. Analysis shows that the carbon percentage of these small sizes is as great as of the large sizes, but they make a less intense fire, and require an additional heating surface in the boiler of 10 to 25% to obtain as high evaporative results. These small coals promise to furnish to the steam users of the East a cheap and cleanly fuel, and one which they would do well to take advantage of much more largely than they are now doing.

Mr. Coxe advocated the purchase of such anthracite under a contract, specifying the sizing and limiting the percentage of ash, of slate and of moisture. The remainder of the paper was devoted to a description of the cheap, simple and easily worked apparatus which has been worked out by Mr. Coxe, by which the quality of small coals may be regularly tested by the purchaser.

The session on Tuesday morning opened with the report of the Council. This was chiefly devoted to a record of the society's work in connection with the maintenance of headquarters at the World's Fair and the entertainment of foreign engineers. During the year 117 new members have been elected and 15 members have died. The present membership in all grades is 1,650, of which 1,361 are members or life members. The society's finances are in excellent condition—thanks to the increase in annual dues made two years ago. The year's receipts were $27,131 and the expenses were $23,020.

The report of the tellers of election showed that President Eckley B. Coxe was re-elected. Messrs. C. E. Billings, of Hartford, Conn.; Percival Roberts, Jr., of Pencoyd, Pa., and H. J. Small, of Sacramento, Cal., were elected vice-presidents for two years. Messrs. John B. Herreshoff, of Bristol, R. I.; L. B. Miller, of Elizabeth, N. J., and W. S. Russel, of Detroit, Mich., were elected managers for three years. After some further routine business the reading and discussion of papers was begun. The first paper presented was a description of the valve gear of the Buckeye engine, by Mr. A. K. Mansfield, Mechanical Engineer of the Buckeye Engine Co. The paper was briefly discussed by some member who could not understand how the gear worked, and Mr. Mansfield promised to present a working model of the gear to the society. The remainder of the morning session was spent in the presentation and discussion of an elaborate paper by Prof. R. H. Thurston, describing tests of the Allis pumping engine at Milwaukee and its phenomenal record of 11.67 lbs. of steam per I. HP. per hour. Something has been said recently concerning the effect of concrete as an irritant. In the most dull, drowsy and prosy meeting of civil engineers let the subject of concrete be brought up and immediately a new interest is awakened and everybody scrambles to be in the fight. Something similar is apt to occur when a "record" steam engine test is brought before mechanical engineers. The discussion was participated in by Professors Peabody and Denton and by Messrs. Rockwood, Ball and Scheffler, and continued until the noon hour.

At the evening session Mr. Geo. S. Morison's paper on "Expansion Bearings for Bridge Superstructures," reprinted elsewhere in this issue, was read, which was followed by papers by Barton Cruikshank, "A Device for Drill Jigs"; F. A. Scheffler, "A Curve Delineator"; Prof. R. C. Carpenter, "Experiments on the Effect of Water Hammer," and Fred. W. Taylor, "Notes on Belting." The last paper, which is an extremely valuable contribution to engineering literature, we begin the republication of elsewhere in this issue.

COMING TECHNICAL MEETINGS.

ENGINEERS' CLUB OF KANSAS CITY.
Dec. 11. Secy., Waterman Stone, Baird Building.
WISCONSIN POLYTECHNIC SOCIETY.
Dec. 11. Secy., M. F. Schinke, City Hall.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
Dec. 12. Secy., F. C. Osborn, Case Library Bldg.
DENVER SOCIETY OF CIVIL ENGINEERS.
Dec. 12. Secy., F. E. King, Jacobson Block.
NORTHWEST RAILROAD CLUB.
Dec. 12. Secy., W. D. Crosman. Ryan Hotel, St. Paul.
NORTHWESTERN SOCIETY OF ENGINEERS.
Dec. 12. Secy., D. W. McMorris, Burke Block, Seattle, Wash.
CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
Dec. 13. Wichita, Kan.
NEW ENGLAND RAILROAD CLUB.
Dec. 13. Secy. F. M. Curtis, P. O. Box 1576, Boston.
ENGINEERING ASSOCIATION OF THE SOUTH.
Dec. 14. Secy., Hunter McDonald, Nashville, Tenn.
ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
Dec. 14. Secy., F. W. Mowbray, Norton Building.
NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
Dec. 15. Secy., D. W. Meeker, St. Paul.
TACOMA SOCIETY OF ENGINEERS AND ARCHITECTS.
Dec. 15. 201 Washington Building.
ENGINEERS' CLUB OF PHILADELPHIA.
Dec. 16. Secy., L. F. Rondinella, 1123 Girard St.
SWEDISH ENGINEERS' CLUB.
Dec. 16. Secy., P. Valentine, At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia. At 180 La Salle St., Chicago. Secy., John Ericson.
COLUMBIAN ENGINEERING SOCIETY.
Dec. 19. Secy., F. W. Hart, Washington, D. C.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Dec. 19. Secy., R. H. Clark, Pittsburg.
WESTERN RAILWAY CLUB.
Dec. 19. Secy., Clement F. Street, Chicago.
ASSOCIATION OF ENGINEERS OF VIRGINIA.
Dec. 20. Secy., L. J. Carmalt, Roanoke, Va.
BOSTON SOCIETY OF CIVIL ENGINEERS.
Dec. 20. Secy., S. E. Tinkham, 36 Broomfield St.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
Dec. 20. Secy., F. Collingwood. 127 East 23d St., New York.
ENGINEERS' CLUB OF ST. LOUIS.
Dec. 20. Secy., Arthur Thacher, Odd Fellows' Building.
CANADIAN SOCIETY OF CIVIL ENGINEERS.
Dec. 21. Secy., C. H. McLeod, Montreal, P. Q.
ENGINEERS' CLUB OF CINCINNATI.
Dec. 21. Secy., J. F. Wilson, 24 W. 4th St.
NEW YORK RAILROAD CLUB.
Dec. 21. Annual meeting. Secy., John A. Hill, Temple Court.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
Dec. 21. Secy., Allen Strale, 100 Washington St.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
Jan. 1. Secy., C. L. Annan, City Engineer's Office.
ENGINEERS' SOCIETY OF PHŒNIXVILLE.
Jan. 2. Secy., W. Haliburton.
WESTERN SOCIETY OF ENGINEERS.
Jan. 3. Secy., Jno. W. Weston, 51 Lakeside Bldg., Chicago.
ENGINEERS' CLUB OF MINNEAPOLIS.
Jan. 4. Secy., E. Nexsen, 504 Kasota Block.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
Jan. 5. Secy., E. E. Smoot, 808 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
Jan. 5. Secy., O. Von Geldern, 719 Market St., San Francisco.
MONTANA SOCIETY OF CIVIL ENGINEERS.
Jan. 13. Secy., G. O. Foss, Helena.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Jan. 18. Secy., S. A. Cherriot, Macon, Ga.
CENTRAL RAILWAY CLUB.
Jan. 24. Secy., H. W. Spear, Buffalo, N. Y.

ENGINEERING NEWS

AND

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ADVERTISING RATES: 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

A story has been going the rounds of the trade papers lately, intended to illustrate the vast superiority of the good old-fashioned practical rule-of-thumb man to the modern engineer with his theories and formulas and computations. It is not bad, as a story, and runs about as follows:

An engineer who had had a fine education and was thoroughly posted in all the theories and principles of bridge construction was intrusted with the design of a large and important bridge. He carefully computed the strain in each piece, and proportioned each according to his computations; but the bridge fell when the first freight train went over it. The engineer was astounded and said it must be due to poor material, so he went and looked at the wreck; but the fractures showed the material to be of excellent quality. Then he told his assistants to go over all their calculations and see if a mistake had been made. They did so, but could find nothing wrong. Then he shut himself up with all the details of the computation in his private office and for 24 hours nothing was seen or heard from him. In the afternoon of the second day he emerged from his den, and one of his assistants heard him mutter as he walked away: "D—n that decimal point."

The originator of this story betrayed his ignorance by selecting bridge construction as the field of engineering work in which to compare the engineer and the so-called practical man. We do not now recall a single branch of industry in which the displacement of rule-of-thumb men and methods by engineers and scientific processes has been so complete as in bridge construction. This has occurred for the very good reason that no mere "practical mechanic" can possibly proportion the various members of a bridge structure or compare the merits of different designs unless he knows something of the character and amount of the strain in different portions of the structure. The engineer in the story ran the risk of making an error, indeed, when he computed the strains and proportioned the members; but how much better was it to run this risk than to rely on guesswork all the way through, which is essentially what the rule-of-thumb man does.

It is needless to tell the readers of Engineering News that in every well organized and reputable bridgeworks the computations are so made and so carefully checked by independent computers, and by graphical and mechanical methods that the possibility of dangerous errors occurring through a mistake in computations is reduced to an infinitesimal figure.

Unfortunately, the general public is not so well posted as to what engineers can and cannot do, and the circulation of even such stories as that related above has doubtless a tendency to injure the standing of the profession and to weaken public confidence in its work.

We are reminded of the above story by a correction which this week reaches our desk, and which at first sight seems to be a close parallel to the above fictitious incident, though the distinction between the two is really clear. In our issue of Nov. 2, we published a paper by Mr. C. O. Mailloux, M. Inst. Elec. E., on the "Use of Storage Batteries in Electric Generating Stations," read at the Milwaukee meeting of the American Street Railway Association. In the latter part of the paper (last column, on p. 359) the author computed the saving due to the use of such batteries in a hypothetical case, and said:

> Taking the cost purposely at the highest figure, $0.65 per K-W.-hour, the initial cost of the battery, of say, 1,300 K-W.-hours, erected, will be $8,450.

He then proceeded on this basis to compute the annual depreciation and interest on the investment. It will be seen that the above quotation, as it stands, is erroneous, for $1{,}300 \times 0.65 = 845$, not 8,450. But the error in the final result was that it was ten times too small instead of ten times too large, for the cost of the battery was $65 per K.-W.-hour, as given by the author himself on the same page, thus making the actual first cost of a 1,300-K.-W. battery, $84,500.

The author now publishes a correction of this slip; and he states in addition that he has found since his paper was presented that large central station batteries can be put in for not more than $35 per K.-W.-hour, complete, that the cost of maintenance will not exceed 10% (instead of 15%, assumed in the original paper), and that the capacity of the battery in kilowatt-hours need not be more than three times the highest rate of discharge, instead of four times. Figuring with these quantities he finds that a storage battery will just pay 6% interest on its cost where coal costs $3.15 per ton; in his original paper he concluded that it would do this when coal cost $1.10 per ton. This puts quite a different aspect on the storage battery question, and makes it doubtful whether, even in the localities where coal is very costly, an electric railway manager could wisely experiment with storage batteries in his station. Of course, no one is going to install so costly a plant as a large storage battery unless it will pay much more than a mere 6% interest on its cost. The managers of central lighting stations appear to find storage batteries a paying investment, but it does not follow that they would pay in street railway stations, and it is safe to say that no one will undertake their use in this field without some more careful computations than Mr. Mailloux made. In justice to him it should be said that he offers in explanation of his "slip" that his paper was written on the train en route to Milwaukee and so hurriedly that there was no time for revision or correction. Any man may make a blunder in a computation; but we take it that neither Mr. Mailloux nor any other engineer worthy of the name would ever make so gross and transparent a mistake as that above described in computations intended for actual work. The moral we would seek to draw is that engineers should be as careful in giving figures and making computations for publication as they are in their regular daily work.

The fact that it is possible to give fictitious strength values to cement by applying the load in tensile tests very rapidly or very slowly, is not so generally understood by engineers as it should be. Fortunately, this does little harm, mainly because no very wide variations in strength are caused by such differences in rate of loading as are likely to occur in ordinary practice, even if custom had not established something like a standard rate. A correspondent, Prof. A. Marston, of the engineering department of the Iowa State Agricultural College, gives in another column some figures showing the effect of applying the stress at various speeds upon the ultimate strength of cement, which forcibly illustrate the importance of fixing a uniform rate for applying the load. From these tests it will be seen that it is possible to obtain results from the same sample of cement which are widely at variance with each other. They show also that variations in the rate of loading between 200 lbs. and 400 lbs. per minute do not materially affect the breaking strength, if it be remembered that at least from 10% to 20% variation must be allowed for irregularities in briquettes and testing machines in any series of tensile tests. A speed of 400 lbs. per minute has come to be quite generally adopted in applying the stress, and is probably as satisfactory as any, both for securing average results and in the length of time occupied in making the test. While it is important for the sake of fair comparison, that there should be some fixed rate of speed in applying the stress, any splitting of hairs over differences of a few pounds per minute in such a standard is entirely a waste of time.

The only other experiments of a similar character which we now recall were made by Mr. Henry Faija, Assoc. Inst. C. E., and were described in the Proceedings of the Institution of Civil Engineers about ten years ago (Vol. LXXV., p. 213). These experiments comprised the breaking of 600 briquettes of Portland cement at rates of loading varying from 100 lbs. per second to 100 lbs. in two minutes and gave results which vary considerably from those obtained by Professor Marston. These results were as follows:

No. briquettes tested.	Rate of loading, lbs. in sec.	Average strength, lbs. per sq. in.
129	100 in 1	560.75
129	100 in 15	508.43
145	100 in 15	452.2
145	100 in 30	430.96
190	100 in 30	417.27
90	100 in 60	402.05
40	100 in 60	416.75
40	100 in 120	400.87

Great care was taken to have the gaging done all at one time and by the same person, and it is probable that a fairly good average was obtained. Taking 100 lbs. in 120 seconds as a common starting point in both sets of tests, it will be seen that the gain in strength by increasing the rate of applying the load to

100 lbs. in 60 sec'nds is, for Faija, 3.96%; Marston, 9.4%
100 lbs. in 30 sec'nds is, for Faija, 7.48%; Marston, 3.0%
100 lbs. in 1 sec'ond is, for Faija, 14.9%; Marston, 38.5%

Judging from these figures, no general rule can be formulated for the variation in the tensile strength of cement with the speed of applying the stress. The number of tests made by Professor Marston, however, was too small to establish his figures conclusively, and the results of a very large number of tests would need to be compared before it could be said that no such rule exists. The general fact that the rate of applying the stress between any very wide limits has an important influence upon the breaking strength would seem, however, to be pretty conclusively established.

THE EDUCATIONAL VALUE OF EXPERIMENTAL WORK.

In forwarding one of the graduating theses for the competition whose result is announced in another column, one of the professors of one of our leading engineering schools appends the following note to his certificate as to the authorship:

> The thesis has been examined by me and is indorsed as one worthy of entering the competition. But I regret very much that the conditions governing your award are such as forbid theses of this character from obtaining prizes. A thesis is understood by me to be a part of the evidence whereon the college is warranted in conferring the degree, evidence of ability to apply principles and make designs. Our best theses from this point of view have no chance in your competition.

The thesis accompanying this note was a highly creditable one, giving evidence of thorough training and promise of good engineering capacity, and was a fully worked up design for a specific structure, namely, a long span bridge across a river at the college town. It is perfectly true that under the conditions to which exception is taken, and to which we feel bound to adhere, such a thesis and design has small chance of receiving an award,

and no chance at all unless the design is of such merit that we would be likely to publish it if submitted by any practicing engineer in advance of actual construction, either as embodying some new principle of design or as applying old principles in a new way. The conditions to which exception is taken are in detail as follows:

The basis of selection for premiums will be the same as that used in selecting papers for publication in engineering journals or society proceedings; that is to say, theses will be graded according to their apparent permanent value for the advancement of engineering practice or theory, either as records of original research or as intelligent and concise discussions or critical summaries of older researches. Clearness, conciseness and care in summarizing conclusions will be essential merits for a high award.

It is perfectly true that under these terms a thesis, which merely shows that the author is entitled to graduate, as giving "evidence of ability to apply principles" (i. e., old principles laid down in the books and determined by others) "and to make designs" (i. e., old and familiar types of design modified only in detail from blueprints which are or might be under the student's eye as he works) and nothing more, has no chance whatever of obtaining an award if fairly judged under the above conditions.

Why should it? Strictly speaking, such work is not engineering; it is shopkeeping work. Many a good engineer has to do shopkeeping work chiefly, and yet is and needs to be a good engineer, because he constantly has to be making little departures from past precedents or (what is the same thing in effect) has to decide not to do so for good reasons. But the essence of engineering as such is the doing of things in a new way to suit new conditions, such as are more or less present in most new works, and potentially are present in all.

When, therefore, a student has shown the capacity to go beyond a re-hash of the specific things he has been taught, and to venture out into the unknown and bring back therefrom new facts which are really an addition to the body of knowledge, even if small, we submit that he has shown a greater presumptive capacity for engineering work by a small achievement of that kind than may be inferred from much more elaborate work involving no element of originality. It seems to us that his thesis simply as a thesis—as an evidence of fitness for graduation—is presumptively entitled to higher rank, because he has done an inherently more difficult thing.

Even if this be not so—if the fair standard for judging theses as such be quite different from that of papers for publication in technical journals or society proceedings—still, it is evident from the facts presented in another column and in our first issue for the current year that papers of high merit as contributions to knowledge are occasionally produced by students as graduating theses, and papers of some merit in that respect quite frequently, even though the percentage of them be small, as it always will be. It is surely fitting that such papers should have proper recognition as such, and should be published for the benefit of the profession as well as of the authors, apart from the issue whether they are or are not better evidences of engineering capacity than other theses which have no other value, and which are of no interest to any one but the author.

If, therefore, any such papers are in fact produced in such number as to make a real competition and a real choice between them, we hold the establishment of premiums open to such theses only to be amply justified; otherwise not. Several friendly critics two years ago expressed a belief that they were not, and that our project would therefore fail. We thought this possible ourselves. The result has proved quite otherwise. In proof thereof we submit the papers which have received prizes this year, expecting them to be judged as we have judged them, i. e., making no allowances for their origin, but considering only their absolute value as contributions to knowledge. Thus judged we assert their merit to be high, surprisingly high. When and if they cease to be so our offer of premiums will stop; but our expectation of probabilities is shown by the fact that we offer this year four premiums to the aggregate value of $250 instead of three, to the aggregate value of $150, as heretofore.

We have still another motive for doing this. We are disposed to believe that it would be highly beneficial to every student of engineering if a requirement of every course was that the student should devote some considerable time to an absolutely original experimental investigation in an unknown field. Nothing else gives such a realizing sense of the limitations of personal knowledge and of the intricacies of natural law involved in every attempt to cope with it. Mere experimental manipulation can be taught by doing over and over old experiments leading to known results, and it is a most valuable drill which is rarely omitted; but its moral effect on the student is entirely different from that of being thrown solely on his own resources in a considerable investigation leading he knows not where. Doubtless most students will do such work haltingly and imperfectly, but even in the attempt they gain most of the good to be had from success, which is, to acquire a consciousness of their own limitations and the uncertainty of doubtful things. Every engineer who has ever made such investigations must be conscious that he profited greatly by them in this way, whatever their final results.

If such work is to be done at all in a college course the natural time to do it is in preparation for a graduating thesis, and whether or not it be wise to compel every student to attempt it, it is surely wise to encourage all to do so. We firmly believe that if one-eighth part of every engineering course were devoted to such work solely, the graduates would prove of better average quality in the end, though their apparent acquirements, as measured in studies which they had "gone through," were considerably curtailed.

For it is a singular fact that it is only in such investigations of physical laws that the human mind has an opportunity to measure itself against absolute truth, and thus to gain the certainty that, unless all its premises and intermediate results are sound, its final results will not be sound; that it must be either right or nowhere. Historical, mathematical, logical, statistical and all other lines of investigation are beset with sources of human error, so that a man can never be quite sure after all but what his deduced "truth" may be a lie, whenever he has ventured outside of the narrow line of precisely defined knowledge. But a question put to nature admits of but one answer, and that the true one. If the answer is not consistent with the question, then the question is not what we thought it was, as we soon find out by attempting to ask the same question in another way. After a few contests of this kind with the difficulties of absolute truth every man feels more or less like the fabulous monkey—"he may not be so handsome as he was, but he knows more"; while nothing breeds cock-sureness faster—that worst vice of the engineer—than working solely in a field of knowledge which came to us without effort as a gift from other men.

LETTERS TO THE EDITOR.

RATE OF APPLYING THE LOAD IN CEMENT TESTS.

Sir: I notice in your issues of Oct. 26 and Nov. 9 communications referring to the effect of varying the rate of applying the stress in making cement tests. In view of the lack of data on this subject, the results of a few experiments which I made in 1890, while in charge of the construction of the Ouachita Bridge, near Columbia, La., may be of interest.

The experiments were upon neat briquettes of imported Portland cement, which were allowed to stand 24 hours in the air, and then kept 7 days in water. Three sets of eleven briquetts each were made, and one briquette of each set was broken by stress applied at each rate of speed given below. The tests were made on an ordinary Riehle testing machine of 1,000 lbs. capacity.

The following table gives the averages of the three results for each rate of applying the stress:

Rate.	Tensile str'gth, lbs. per sq. in.	Rate.	Tensile str'gth, lbs. per sq. in.
100 lbs. in 1 sec.	550	100 lbs. in 30 sec.	446
100 " " 2 "	547	100 " " 60 "	473
100 " " 4 "	509	100 " " 120 "	433
100 " " 7 "	470	100 " " 300 "	394
100 " " 10 "	461	100 " " 600 "	387
100 " " 20 "	493		

I found also by trial that the briquettes would break under very much smaller loads than the above, if the load was kept on long enough. In one case the briquette resisted the stress several hours before breaking.

The conclusion drawn was that the effect of varying between wide limits the rate of applying the stress was very great, but that for a range of, say, between 200 lbs. and 600 lbs. per minute the effect was not greater than that of the other irregularities of the tests.

Are you not in error in stating that Mr. Faija's results contradict those of Mr. C. B. Smith?

Very truly, A. Marston.

Ames, Ia., Nov. 13, 1893.

(We have discussed this question in our editorial columns.—Ed.)

STEEL TIES ON THE NEW YORK CENTRAL R. R.

Sir: The experimental lot of 800 steel crossties put in the Hudson Division main tracks south of Garrison have now been in service over four years. I call for a special report upon them every year (but somehow omitted it last year), and the following is the substance of the report just made to me by Mr. O. W. Eggleston, Assistant General Roadmaster for the last two years, nearly:

At this date these ties are all in good shape as to line and surface and the bolts are in good tight condition. Since the last report, made Feb. 1, 1892, we have noticed no perceptible change in the condition of these ties, excepting that it is necessary to tamp them up occasionally when they become loose. The cost of the labor in so doing since Feb. 1, 1892, is $75.94, which averages about 4.7 cts. per tie per year. The last report was a fraction over 5 cts., indicating that the condition of these ties is really improving. During the past two years we have renewed 58 of the clip bolts, which were twisted off in trying to screw them up tight. The labor cost of this, which is included in the above-mentioned sum ($75.94), is $8.81, or say $4.40 per year; 58 bolts equals about 1.8% of the whole number, indicating a yearly renewal of bolts of only about 0.9%, which I regard as a very good showing. During the early part of last spring a freight car was derailed and ran over the entire length of these ties causing slight marking and denting near the center of the ties, but otherwise doing no damage.

I regard this on the whole as a very excellent showing for these ties, and in the improved model such as those we now have on hand for the Fourth Ave. tunnel tracks, being depressed in the center and covered by ballast (Eng. News, March 12 and April 2, 1892, and Sept. 7, 1893), the injury above reported by wheels off track will not occur.

Yours truly, Walter Katte,
Chief Engineer, N. Y. C. & H. R. R. R. R.

New York, N. Y., Nov. 28, 1893.

CONCERNING CEMENT TESTING.

Sir: I agree with your correspondent R. A. C. (Eng. News, Nov. 9) with regard to testing cement, except where he seems to assume that the total volume of interstices in coarse sand is greater than in fine. There is an indefiniteness in the terms "coarse" and "fine," as commonly used. I should say that given a coarse sand of even grain, and a fine sand of even grain and with grains of exactly the same shape, the total volume of interstices per cubic foot would be exactly the same. But supposing the grain of the fine to be half the diameter of the coarse, the fine grains composing a cubic foot would have at least twice the area of surface as the same bulk of coarse grains, and if Mr. Feret has happened to strike these sizes it would look as if mortars having the same percentage of cement and water, and otherwise treated in the same way, would have strength proportional to the diameter of its sand grains. It would be well to have Mr. Feret's "coarse" and "fine" more clearly defined. What sieves did they pass and on what were they retained?

Let us consider a mortar composed of an ordinary quartz sand weighing 100 lbs. per cu. ft., dry and loose, with Portland cement paste, in which the water is in weight 0.4 times that of the cement, and with the addition of further water equal to 0.05 the weight of sand. Such a sand, when wet and compressed, will have 114 lbs. of sand per cu. ft., and will have a volume of interstices capable of holding rather less than one-sixth of its volume of packed cement.

Gillmore, Chap. VIII., p. 321, of "Limes and Cements," would add 5% more water to the sand, which would reduce the proportion of the cement that would fill the natural voids in the compacted sand. This is not instanced as a mortar for testing purposes, but a practical one, and the sand grains are supposed to be non-absorbent. It goes to show that a mortar with just sufficient cement paste to fill the voids is not one that would be considered strong, and that the enveloping of the grains of sand with a considerable body of cement paste is necessary, with present materials, to make a strong mortar.

The writer would emphasize the opinion that testing cement neat is of little practical value, except where it is to be used neat; and that in experimenting

with it there are two ends to be kept in view, viz., the comparison of different samples and brands; and the defining of the different results that should obtain in practical use, under known conditions. The first is best attained by trial with a standard quality and quantity of sand and water, somewhat as defined by the committee of the Am. Soc. C. E., though other tests may often also be necessary. It is to be hoped that our societies will bring their standards to greater perfection. With regard to the second point, it would be very interesting to have a consecutive set of tests and know, among other things:

1. The volume of each brand of cement in its standard barrel.
2. The net weight corresponding to said barrel.
3. The amount by weight of water that can be added to each barrel without an increase of bulk.
4. The best proportions of cement and water for different brands of cement and for different uses.
5. The comparative strength of mortars with different brands of cements, different grades of sand and different percentages of water, giving comparative results, with all coarse grains, all fine grains and mixed coarse and fine, and defining what proportions of water should be added to obtain best or desired results with the sand for different purposes. A proportion best for testing may not be practicable in making concrete.
6. The effect of using sea water in mixing.
7. The results of accelerated tests with various proportions of materials and with the admixture of sea water, ammoniacal liquor, alum and soap mixture, or other chemicals.
8. The comparative strength of concrete made with broken stone or with gravel but without sand; with broken stone and sand; with gravels and sand; with broken stone, gravel and sand, and with different kinds of each ingredient.

This, with other additions that may be suggested, would supply a year or two's work for some poor devil these hard times.

Some years ago there was quite an extended set of experiments described in the report of the city engineer of some New England town. I have not been able to lay my hand on it, and am not certain whether it was Providence, R. I., or not, but it was noticed in Engineering News (July 4, 11, 1885.—Ed.) and went to show that coarse sand made stronger mortar than fine. It would be of interest if you could give us the composition of the 20 different kinds of concrete indicated in Figs. 1, 2 and 3 (Eng. News, Nov. 9, p. 367), and let us know what the constant b was found to be; and explain the extra numbers that appear in the first column of Table 1, p. 368. There would seem to be a "½" and a "1" too much in the proportions for the 4th and 6th compositions represented. Yours,

J. S. Armstrong.

St. John, N. B., Nov. 20, 1893.

(The number of experiments was considered insufficient to establish the constant b. It varied from 22 to 75 in different experiments. As the composition was different for nearly every specimen tested, we could not give it without taking more space than its value seemed to us to warrant. Our correspondent will find the complete paper in the "Proceedings" of the Institution of Civil Engineers, Vol. CXIII., p. 217.—Ed.)

TROUBLE IN FOCUSING.

Sir: I have in my classes several students who at times cannot see the spider lines in a certain transit. Focusing the eyepiece does not seem to help them. They have no trouble with other telescopes, nor do these same students always have trouble with this. Removing the eye from the instrument for a time enables them to see the lines for a moment, but they soon fade away.

My theory is that they are thinking so intently of the image that they entirely ignore the lines, but I cannot explain why the same thing should not take place with another transit which we use.

These students have excellent eyesight in general. When the instrument is thrown out of focus, or is pointed toward the sky, the lines are seen readily by all. Can any one explain the matter, and give a remedy for an idiosyncrasy that proves to be very discouraging to some of the young men? Very truly,

J. B. Johnson.

Norwich University, Northfield, Vt., Oct. 28, 1893.

(We would first advise the thorough overhauling of this certain transit; especially as these same students have "no trouble with other telescopes." We know engineers, however, who always have some extra trouble in focusing owing to some slight inherent defect in their eyes; but aside from a little annoyance at times, this difficulty should not be a cause for discouragement to the young men in question.—Ed.)

TRANSITION CURVES—LOGARITHMIC SCALES.—FORMULAS FOR ELEVATION OF CURVES.

Sir: In your criticism of Professor Crandall's book on transition curves you speak of "the fact that these (the offsets) should vary approximately as the cube of the degree of curvature."

Is there not another fact, viz., that it is allowable and practicable for a train to approach a 2° curve at a very much greater speed than it might a 20° curve, so that a relatively much shorter transition, and, therefore, with offset less than a 1,000 times that of the 2° curve, would answer perfectly? Again, for ordinary railway work (say up to 50 miles an hour), would not a displacement of .052 answer for a transition to a 2° curve? Then why, for the sake of even figures, frighten us with the idea that it takes a final tangent offset of 4,000 ft. to strike a 20° curve? Perhaps I am wrong in interpreting your term "offset," but even 1,000 ft. is wild enough.

What is your idea with regard to the minimum offset, or displacement, as I call it, allowable for transition to a 2° curve on a road when 50 miles an hour is the maximum speed allowed on straight track, and with track set exact to gage at and for a short distance at least before the beginning of the transition curve?

What is your opinion of the Wicksted formulas that the superelevation on curves may in practice be made equal to 0.1 of the square root of the curvature, giving the elevation in tenths of a foot?

Referring to another matter: You published on Nov. 9, 1893, an account of a logarithmic rule, described as on a sheet of letter paper. Very much the same thing is described by Mr. T. R. Roseburgh in the papers of the Engineering Society, School of Practical Science, Toronto, No. 3, 1889-90, but giving it in more convenient form and more extended use,, showing how it may be made applicable to obtaining the elements of triangles. He extends the scales backward and forward, repeating part of the line above and of the one following, and uses runners of tracing cloth, one for use, as with logarithmic numbers, and the other runner having logarithmic sines, numbered with the angles they represent.

Then, again, as to Prof. W. F. Durand's logarithmic square: If some of the engineering supply companies would give us two such squares, one above the other, ruled on porcelain, with the dividing line on an inlaid metal strip, it would work very conveniently. The porcelain would allow of pencil lines being ruled on it for temporary use, and the upper and lower logarithmic square would enable the logarithmic multiplier, or the complement thereof, to be taken by the compasses without raising them from the surface—the one above the line, the other below. Yours,

J. S. Armstrong, M. Can. Soc. C. E.

Montreal, Nov. 25, 1893.

(It is true that differences of speed may legitimately be considered in selecting particular transition curves. That does not prevent the law being as stated if it is desired to use curves changing in degree by a given quantity in a given distance. The minimum length for a 2° or any other transition curve should be as large as can be conveniently obtained up to a foot or more, provided high speeds are expected. If they are not expected, or if there are many other much sharper curves, a 2° curve may without sensible harm be left without transition curves. Pottering about with such offsets of 0.052 is, in our judgment, mere waste of time. Within a year after track is laid it will vary more than that under the guidance of the trackman's eye, often four or five times that. The Wicksted formula for elevation is in our judgment excellent, leading to better practical results than any other.—Ed.)

ENGINEERING NEWS THESIS COMPETITION.

ANNOUNCEMENT OF AWARDS.

The awards under our second annual tender of prizes for the best graduating theses submitted by graduates from engineering schools in 1893 have been awarded as follows:

The first prize of $75 has been awarded to the thesis entitled "Comparative Tests to Determine the Availability of the Method of Transverse Breaking vs. Direct Tension in Testing Cement."

The second prize of $50 has been awarded to the thesis entitled "Nails and Drift Bolts."

The third prize of $25 has been awarded to the thesis entitled "Experiments to Determine the Power Absorbed by a 56-In. Circular Saw."

Honorable Mention, accompanied in each case by two years' paid subscription to Engineering News, is awarded to the following theses:

1. "An Investigation of the Effects Produced by Punching Cold Steel Plate."
2. "The Testing of Iron and Steel by Impact."
3. "An Experimental Study of Railway Track Joints."
4. "Tests on Nails."
5. "Garbage Cremation in America."

The names, addresses and college of the authors of the above papers are given in the following letter from Mr. Francis Collingwood, Secretary of the American Society of Civil Engineers, who kindly consented to receive the theses and the accompanying data as to authorship, and to open the same and certify the results to us after notice of the awards:

To the Editor of Engineering News:

Sir: I am in receipt of your letter of the 2d of December, in which you advise me of the awards in the second "Annual Thesis Competition," instituted by Engineering News, and in which you request me to open the envelopes and advise you of the name, address and college of the authors of each paper receiving an award.

The paper entitled "Comparative Tests to Determine the Availability of the Method of Transverse Breaking vs. Direct Tension in Testing Cement," to which you have awarded the first prize of $75, is by Herman E. Abbott, of Hanover, N. H., and Edwin J. Morrison, of Henniken, N. H., graduates in civil engineering from the Thayer School of Civil Engineering, of Dartmouth College.

The paper entitled "Nails and Drift Bolts," to which you have awarded the second prize of $50, is by F. W. Clay, of Richmond, Ky., a student of Cornell University.

The paper entitled "Experiments to Determine the Power Absorbed by a 56-Inch Circular Saw," to which you have awarded the third prize of $25, is by Robt. C. H. Heck, Heckton Mills, Pa., and Henry B. Evans, of Dayton, O., graduates of Lehigh University.

The papers to which you have awarded Honorable Mention are by the following authors:

1. "An Investigation of the Effects Produced by Punching Cold Steel Plate" is by Geo. S. Allen, Cleveland, O., graduate of the Case School of Applied Science.
2. "The Testing of Iron and Steel by Impact" is by Paul Bright, Pittsburg, Pa., graduate of the Western University of Pennsylvania.
3. "The Experimental Study of Railway Track Joints" is by G. E. Hayward, Waterford, O., graduate of the Ohio State University.
4. "Test on Nails" is by James C. Hain and Frederick F. Fowle, graduates of the University of Wisconsin.
5. "Garbage Cremation in America" is by Chas. T. Bayless, of Louisville, Ky., and Arthur E. Merkel, of New York, graduates of the Stevens Institute of Technology. Yours truly,

F. Collingwood, Secy. Am. Soc. C. E.

127 E. 23d St., New York, Dec. 5, 1893.

The Columbian Exposition has caused more delay in the announcement of these awards than we hope will be again necessary. The corresponding awards for last year were announced in our issue of Jan. 5, 1893.

The paper to which the first prize is awarded was the unanimous and independent first choice of all the seven judges, barring some slight hesitation on the part of one of them due to a misapprehension. If the only effect of our establishing these prizes had been to bring that one paper to the notice of the profession we should feel amply repaid for doing so. Without making any allowance for its origin or for the youth of its authors, it must be classed, in our judgment, as a remarkable and notable paper which is likely to attract the general attention of the profession and to have no small effect on its future practice. Our sense of its merit will be best indicated by announcing our intention to reprint it with some correlated matter in a little manual on "Practical Cement Testing," of which it will be the leading feature. It will be published in full in our next issue. We may add in conclusion that the task of the judges was simplified by the fact that the paper was excellent in form as it was in substance.

This last is also true of the paper on "Nails and Drift Bolts," awarded the second prize, and

which is also a paper of real and permanent value, in our judgment, as dealing effectively and almost completely with a single subject, and contributing new experimental facts thereto of some probable importance. We shall publish this paper in full in an early issue, and in connection therewith an abstract of the paper on the same subject to which our fourth Honorable Mention was awarded. The last was a most creditable production for a graduating student, and necessarily contains technical matter of permanent value in the opinion of the judges, since that is a necessary condition for any award. Nevertheless, the contrast between the two papers throws an instructive side light on the difference between doing a thing with an eye to completeness and practical results rather than mere abstract investigation, and on how little difference there may be between doing the one or the other except in the habit and instinct of thoroughness.

The paper on tests of a circular saw, to which the third prize is awarded, is a somewhat notable example of the attainment of useful results under difficulties. As evincing the qualities of mind which make the engineer it is deserving of high rank.

The thesis on punching steel plates, to which the first Honorable Mention was awarded, might possibly have received a higher award except that the investigation seemed to have been less complete and decisive than it might easily have been made with but little more trouble. The time which can be given to thesis work is often necessarily limited, and any defects which necessarily result from that cause are the author's misfortune, but not his fault. But when it is clear that a very little more time given to an investigation would have added materially to the value of the results, such a defect is counted positively as a demerit under the rules which we have established.

The paper to which our second Honorable Mention was awarded, on testing iron and steel by impact, suffered also from this cause. The admirable choice of subject (in a fruitful and too much neglected field), the excellent testing machine which was devised by the author, and his general method of making tests, gave promise of a paper which would deserve a high award; but the promise was not maintained in the amount of testing which was done after thus preparing for it, and, above all, elastic limit determinations were almost ignored, and there were other defects into which we cannot now enter. The literary form of the paper was also bad. These features of conspicuous defect almost overbalanced its features of conspicuous merit. We shall publish a full abstract of this paper, as outlining a hopeful method for further investigation, and giving some actual results of real value.

The paper to which our third Honorable Mention was awarded (An Experimental Study of Track Joints) in everything except in the final value of its results would, perhaps, deserve a much higher rank. It certainly does credit to the acquirements and capabilities of the author, who, "if he failed, failed in a great undertaking." He made an ingenious and creditable effort to solve some obscure and almost indeterminate problems by a limited number of observations. He invented a novel machine to that end and used it well, and he succeeded in shedding some new light on the subject which we shall give in abstract later. But to secure results from which one could generalize with any safety several times as much experimenting would be necessary.

It was with regret that we could not award to the paper on "Garbage Cremation in America" a higher rank, but it was not as complete as the author thought and said it was, for lack of facts which could have been ascertained by seeking more carefully for readily available information. Considered merely as a thesis it was very well done. Our intention was and is to select but three papers for Honorable Mention, but justice seemed to require this year that we should select five.

The average quality of the theses submitted was distinctly higher than last year, or we could not have selected eight in all for some award. Under the terms of our competition their average quality must be pretty high, since they are sent in not by the authors, but by the authorities of their several colleges, accompanied by a certificate that the thesis has been already carefully examined, is original work and is indorsed as in all known respects worthy of entering the competition under its terms. We are pleased to say that in no single instance did this certificate appear to have been given carelessly or improperly. Every paper submitted had certain conspicuous merits and was highly creditable work for any student to do.

Among those receiving no award we should, perhaps, specially mention a paper on the "Bearing Power of Piles," which recorded some apparently valuable and accurate experiments made on a somewhat novel plan for comparing the actual safe load of piles with that given by sundry pile-driving formulas. The results of these experiments were highly complimentary to what has become known as "Engineering News" formula for safe load—too much so to have justified the author in stopping short with his experiments where he did, after having his experimental plant completed and in working order. Partly for this reason, partly because the hiatuses in the series of experiments gave cause for suspecting that some observations which were not so consistent had been silently dropped, but chiefly because the author failed to do what he might have done by an hour's more work, i. e., plot lines for several other formulas besides the one mentioned on his diagrams, the judges felt compelled to give this paper too low a rank for any award. Nevertheless, it contains information of real value which we hope to publish later with the author's permission.

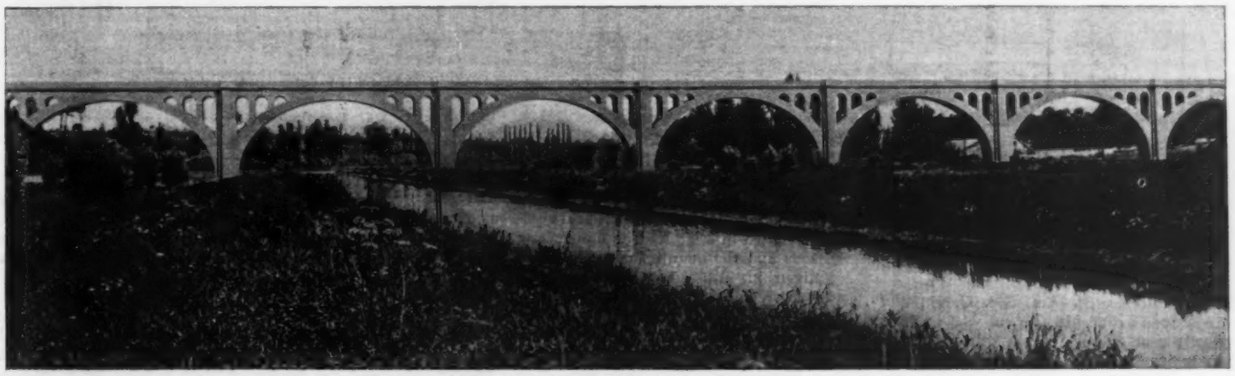
We may, perhaps, say a word usefully here to all beginners in experimental work, to save them from expecting too great consistency in experimental results, since we may frankly say that not one only, but several of these papers have suffered in rank from showing results too beautifully consistent with each other to make it seem a tenable hypothesis that they not only told the truth, but the whole truth. To err without rhyme or reason is the very nature of single observation in all experimental work. We use the word "err" in its primary sense of "wandering about." In the mind of any one used to such work, it is not the presence, but the absence of such erratic observations which excites suspicion. While we have no reason to believe, and do not believe, that experimental results were intentionally "doctored" in any of the papers submitted to us, we find ourselves compelled to believe that, rather from inexperience than from bad intent, a certain selection has been exercised based on the wholly erroneous premise that results which were not reasonably (i. e., closely) consistent with others must therefore be defective and hence ought to be dropped out. Experienced and conscientious experimenters are extremely reluctant to do this, and only do it when there is the clearest ground for doing so.

Another form of the same general error lies in presenting on separate diagrams results which, separately considered, seem entirely consistent, but which, if combined on one diagram, are found to be much less consistent or even wholly inconsistent. In this way, for the worthless gain of a greater outward consistency, the opportunity is lost to generalize results, and thus gage their real worth. Papers on the loss of head in valves and elbows and on the transmission of heat from steam through iron pipes, among others, suffered severly from this cause though in other respects, highly creditable to their authors and likely to have recieved an award.

As a whole, we feel greatly pleased with the results of our second annual competition. We feel even better satisfied than before that its results are likely to be good, and only good, from every point of view. We therefore renew our offer of these premiums for graduating theses for the ensuing year, adding a further premium of $100 for the best thesis or its equivalent prepared as the result of post-graduate work during the usual post-graduate course.

These premiums for post-graduate and undergraduate work will be kept distinct with this exception: All undergraduate theses submitted will be considered as in competition with those of post-graduates, and the condition precedent for awarding the post-graduate premium to any post-graduate thesis will be that it shall be adjudged to be of greater absolute merit than any of those submitted by undergraduates. Otherwise the higher premium will go to the undergraduate thesis. In our opinion, judging only from the results of this year's competition, the post-graduates will have to do some notably clever and creditable work to secure the premium thus tendered them, under these conditions.

The detailed conditions for these awards will be announced next week.



VINGEANNE VIADUCT; FRANCE, EASTERN RAILWAY.

MASONRY BRIDGE ON THE EASTERN RY., FRANCE.

The Eastern Railway of France crosses a number of low valleys by means of masonry bridges and viaducts, one of which is illustrated in the accompanying cut. This handsome structure is situated on the Is-sur-Tille line, and spans the valley of the Vingeanne, near the village of Oisilly (in the department of Cote-d'Or). It is 960 ft. long and 50 ft. high from the bottom of the valley to the level

of the rails, and is composed of seven elliptical arches of 127 ft. span and 46 ft. in height. The foundations rest on solid rock at depths of 12 ft. to 25 ft., and are built up in ashlar and hydraulic cement. In order to lighten the work the spandrels are each pierced by three arches, and the pillars between them, as well as the piers themselves, are pierced with longitudinal openings 5 ft. wide. The piers are hollow, the inner space being 4×10 ft. The viaduct carries a single track railway, and the width between parapets is 14 ft. Above the plinth course and between the refuge niches on the piers the parapet is surmounted with cast iron railings 3 ft. 6 ins. high. Nearly the whole of the work is in stone of small size, with dressed stone for parapets, refuge niches, etc. Dressed freestone, set in slight relief, decorates the heads of piers and spandrel arches. The other face stones are hammer faced. The proportion of superficial area in solid to that empty is 19,378 to 38,756, the total of the areas being 58,134 sq. ft. The total cost was $107,000 at an average cost for masonry of $7.10 per cu. yd. For the illustration and description of this handsome viaduct, we are indebted to Mr. C. King, of Lille France.

It may not be amiss here to refer to the advantages of such masonry structures in durability and minimum expense for maintenance, an excellent example of which is afforded by the Starrucca Viaduct, on the New York, Lake Erie & Western R. R., which was illustrated and described in our issue of Sept. 1, 1888. This structure is 1,040 ft. long and 91 ft. high, with 17 arches of 51 ft. span. It was built in 1848 to the designs of Col.

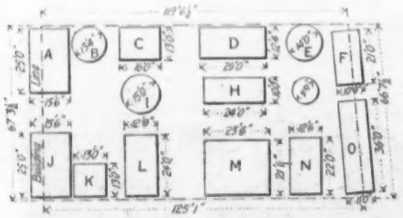


Fig. 1. Plan of Foundations, Manhattan Life Building, New York.

Julius W. Adams, M. Am. Soc. C. E., and the total cost was about $14 per cu. yd., while it has practically cost nothing for repairs since the time it was built.

PNEUMATIC FOUNDATIONS FOR THE MANHATTAN LIFE BUILDING, NEW YORK.

The pneumatic process of foundation sinking is now so familiar to engineers through its use on bridgework that its application to building foundations is not a novelty, in one sense of the word; but in every application of an old process to a new use the changed circumstances often render considerable ingenuity and departures from established practices necessary. We illustrate herewith the caissons used in sinking the foundations for the 16-story office building now being erected on lower Broadway, in New York city, by the Manhattan Life Insurance Co. This building will occupy a space 67 ft. wide with an average depth of 123 ft., and will have a height of 348 ft. above the Broadway curb. It is being constructed with a framework of steel and iron faced with brick and stone. The general style of the architecture is Italian Renaissance richly ornamented.

The great height and weight of the building made the problem of providing a reliable foundation an important one, especially since the methods usually adopted for high buildings in New York and other cities was found to be inapplicable in this case owing to the treacherous nature of the underlying material and the danger of disturbing the foundations of the neighboring buildings. It was therefore decided to use the pneumatic process, in order that a foundation might be secured which would rest directly upon the underlying rock, which at this point occurs about 54 ft. below the level of the Broadway curb. This process, though in common use in the sinking of deep bridge piers and lighthouse foundations, where there is usually abundant room and little harm to be expected from surrounding conditions, had never before this been applied to the securing of foundations for buildings, where the space was limited and where, as in this case, tall and heavy buildings were immediately adjacent. Directly south of the lot was the Consolidated Exchange Building, the foundations of which are on piles, while on the north side was a four-story brick building with foundations set directly in the earth at about 26 ft. below the Broadway curb line. These heavy adjoining buildings necessitated extreme caution, in order that there might be no disturbance of their foundations which might result in settlement.

The most advantageous plan for supporting the new building was found to be one calling for a foundation built upon 15 separate caissons arranged as shown in Fig. 1. The dimensions of these caissons and the quantity of masonry in each pier are given in Table 1. Upon these were placed the bolster shoes for supporting the cantilevers which carry the outside columns and serve to distribute the load. One of these cantilevers is shown in Fig. 2.

The caissons were both circular and rectangular in form and were built of steel. A plan and section of two are shown in Fig. 3 (p. 459). They were built of steel plates, angles and beams. The sides were of ½-in. steel from 11 to 13 ft. high, stiffened with angle brackets made of 6×6-in. angles, and also further strengthened by 7-in. steel bulbs placed horizontally between the brackets. The roofs were of ⅜-in. plates and upon these were placed steel I-beams to support the loads of masonry while the sinking progressed. The sides were carried down a few inches below the bulbs and the foot of brackets, and were reinforced by heavy steel plates 16 ins. wide and ⅞ in. thick and riveted to the outer shell with ⅞-in. countersunk rivets. Each caisson was provided with a shaft 4 ft. in diameter with air lock for the use of men in entering and leaving the working chamber, and also for filling the chamber after the caisson had reached rock. There were also from four to six 4-in. pipes in the roof of each caisson for use as "blowouts" and for the admission of air.

The method followed in designing the caissons gave them sharp and unobstructed cutting edges. All of the caissons, with the exception of the three in the middle of the lot, were sunk within 1 ft. of the walls of adjoining buildings. This close working, and the depth of 34 ft. of material through which the caissons were sunk, rendered it necessary to use extraordinary care that there should be no "drawing in" of material, or serious results would ensue from settlements.

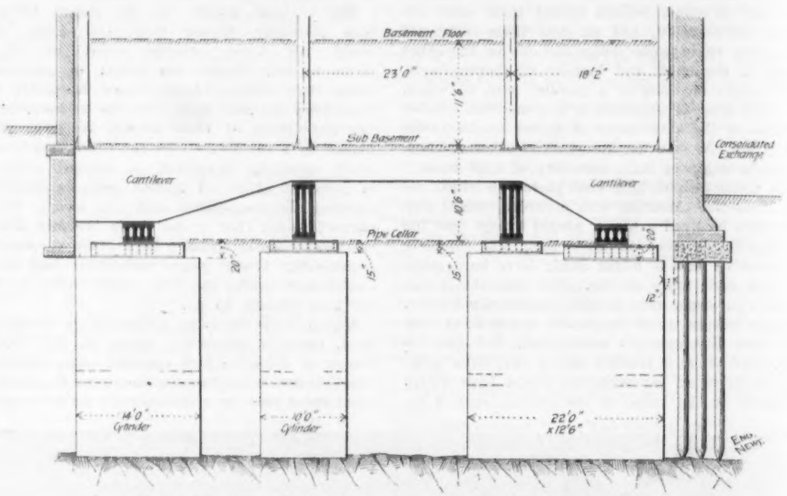


FIG. 2. CANTILEVER FOR MANHATTAN LIFE BUILDING, NEW YORK.

The method of work was in general about as follows: The lot was first excavated over its entire area down very close to the water line; then as space was provided each caisson was brought upon the ground in as large sections as could be economically handled, and "set up" in its proper position. In order to facilitate work, bolts were largely used in the field in preference to rivets for connecting the large sections. Each caisson was well calked. The roof beams, shafting and pipes were placed, and the brickwork then begun. After building up the brick masonry about 6 ft. to 8 ft. in height, the "pressure men" entered the caisson to begin the excavation. The material passed through was fine sand and mud. This material was shoveled up to the mouth of a 4-in. pipe, extending through the roof and superimposed brickwork, in which was placed a valve with full 4-in. opening. As soon as this valve was opened, the pressure of air inside the working chamber forced the material up through the pipe and into the open lot, from which it was hauled away by carts.

As this excavation proceeded the brickwork was added to and the whole mass settled into the hole excavated. The sharp cutting edges were forced well ahead into the material, and this, coupled with the air pressure, which was kept up to something over the hydrostatic head, prevented all flow into the caissons of surrounding material, thus preventing any undermining of adjoining foundations.

The resulting success of this work justified the use of the process, as the contract was quickly completed and in a manner entirely satisfactory to the architects and builders. After the cutting edge of each caisson had touched rock, the latter was thoroughly cleaned and the working chamber and shafts filled with concrete, well rammed. The concrete was made of 1 part Alsen's Portland cement, 2 parts sand and 4 parts broken stone. The brick was good hard-burned Hudson River brick laid in cement mortar of 1 part "Little Giant" cement to 2 parts sand. Upon this brickwork were placed steel shoes which form the pedestals for the cantilevers upon which the building will rest.

The first caisson was delivered on the lot April 13, 1893, and the work was completed Aug. 13.

TABLE I.—Showing the Dimensions of Caissons and Quantity of Masonry in Each Pier.

Dimensions of caissons.	Total height of foundations.	Quantity of brickwork.	Quantity concrete in chamber.
ft. ins. ft. ins.	ft. ins.	cu. yds.	cu. yds.
A. 15 6 × 25	30	308.53	121.98
B. 13¼ cylinder	30	111.15	43.94
C. 13 × 16	31 6	177.10	65.45
D. 12 4 × 26	34	279.18	110.98
E. 14 cylinder	23 6	131.10	48.45
F. 10 9 × 21	32 8	202.03	71.06
G. 9 9 cylinder.	33 9	61.41	23.46
H. 10 × 24	32 10	198.80	75.65
I. 15 cylinder	32 8	158.05	55.59
J. 15 6 × 25	32	317.23	121.98
K. 13 × 13	30	134.59	53.21
L. 12 9 × 24	30 9	252.09	96.31
M. 21 6 × 25 6	31 6	446.90	172.55
N. 12 6 × 22	31 6	234.60	86.70
O. 11 × 36	31 9	341.08	134.70
Total.....		3,393.84	1,212.01

1893, which makes the average time for the sinking and completion of each foundation only eight days. The work was done under the direction of the architects, Messrs. Kimball & Thompson, 55 Broadway, New York, by Sooysmith & Co., Contracting Engineers, Mills Building, New York.

STANDARD EXPANSION BEARINGS FOR BRIDGES.*

Among the special details of bridge construction one of the most important is the provision for changes of length due to temperature, and while this is a provision which is nearly always made, it is, unfortunately, one of the details on which least care is bestowed. The older devices for this purpose were of three kinds, sliding plates, rockers and rollers. Sliding plates are still largely used, and if properly lubricated and cared for, give pretty good satisfaction for short span bridges. With rockers, which are essentially the section of a wheel, the weight being carried on the axle and the wheel rolling on its circumference, the principal objections have been that the great weight carried on the axle caused so great friction that as the rocker moved back and forth a sliding motion set in which gradually slipped the bearing of the rocker toward one edge and it tipped over. Rockers were used considerably 25 years ago, but they are now almost entirely abandoned. Rollers have always been the favorite device and are almost universally used for the longer class of bridges.

Theoretically rollers ought to give an almost frictionless expansion bearing, but they fail to do so for several reasons. In the older forms this bearing consisted merely of a nest of rollers, usually of small size, placed between two planed cast iron plates, one on the masonry and the other fastened rigidly to the bottom of the end post. Any inaccuracy in the workmanship or any uneven deflection, therefore, disturbed the parallelism and greatly overloaded some of the rollers. This form of bearing was, of course, long ago abandoned and the practice is now to transfer the weight of the bridge to the rollers through bolsters. These support the weight of the truss through the end pins and are free to rock. But roller bearings as now constructed are defective in other ways. When boxed in they are difficult to clean and the accumulating dirt increases the friction and owing to their small size often locks them fast, or slews them around. The thin bed plates commonly used become indented and are also a cause of trouble.

European practice has generally been much better than American practice; the rollers used have been of much greater diameter and the bed plates of greater thickness. The use of large rollers has led to the adoption of segmental rollers, the sides of the rollers being planed off so that they could be put close together and still as much cylindrical surface as was actually needed for the prescribed motion retained. These segmental rollers are sometimes so designed that they will shut into each other as they roll, but in many cases the sides are simply planed flat. In Germany they are termed stilts, and their use has become very general. There seems to be only one valid objection to the use of segmental rollers, and that is if moved farther than is intended they will tip over and it will be very difficult to restore them to position. To overcome this fault one method has been to provide the ends of one roller with teeth which mesh into gears in the top and bottom plates. Another method is to make the rollers of such shape that they cannot tip over, but will support each other before they fall.

The expansion bearing shown in the accompanying cut is a development of the author's practical investigations to secure a more perfect bearing and has proved to work very successfully. It consists essentially of a pier casting, upon which is a composite plate consisting of T-rails riveted to a web, which forms the lower bearing surface for the rollers. After being fastened to the bottom plate the rails are planed on top. The segmental rollers consist of 12-in. steel rollers hollowed out on the sides and held by top and bottom plates fastened by the steel bolts in the ends of the rollers. The top plates were made hooked to obviate any danger of the rollers tipping over. On the top of the rollers rests a steel casting with its bottom surface polished and having at its top a socket. In this socket rests a polished steel casting with cylindrical top and bottom surfaces having their elements at right angles to each other. Another steel casting having a socket at its bottom part rests on the top of the cylindrical casting and carries the bolster, which carries the weight of the bridge through the end pin in the usual manner. It is to be noted that this cylindrical casting or rocker plate is primarily for the purpose of allowing the bridge to adjust itself to a uniform bearing on the rollers, and is not designed to permit of motion after the bridge has once become adjusted. In other words, by its use it is intended that such imperfections of workmanship as would tend to cause uneven bearing may be eliminated. If constant freedom of motion was to be provided for the rocker plate would have to be made larger and lubricated. Other details of the construction will be seen from the drawing, as will also the principle of operation.

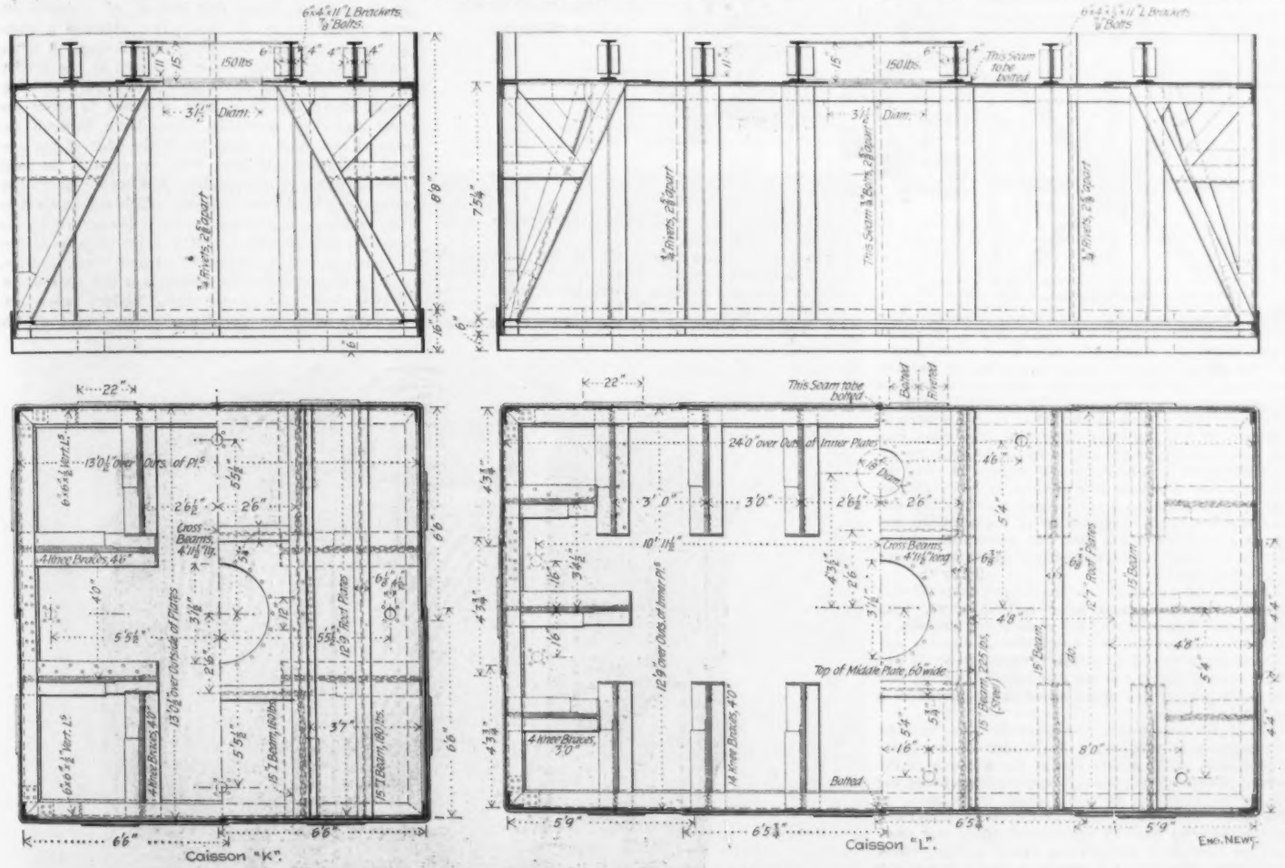


FIG. 3. DETAILS OF STEEL CAISSONS, MANHATTAN LIFE BUILDING, NEW YORK. Sooysmith & Co., Contracting Engineers.

While not a necessary feature of the design the author has always made the length of the rollers a multiple of 6 ins., so that with two rollers the bearing will be 12 ins. square, with three rollers, 18 ins. square, etc. The accompanying table gives the bearing surface, safe load, length of rollers, etc., for from 3-roller to 12-roller bearings, inclusive.

Table Showing Safe Load, Total Bearing Surface, Length of Rollers, Etc., for from 3-Roller to 12-Roller Bearings, Inclusive.

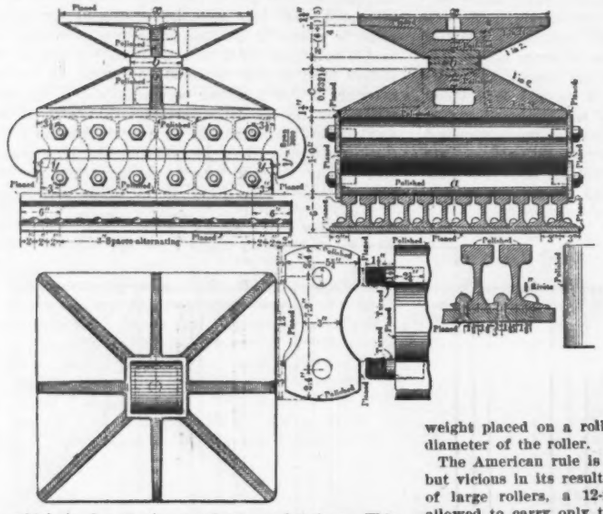
No. rollers.	No. rails.	a Length of rollers, ins.	b Side of rocker plate, ins.	c $a-(b+1.5)$ / 4 ins.	Total bearing, ins.	Safe load at 3,000 lbs. per lin. in., lbs.
3	6	17.5	4	3.	45	135
4	8	23.5	5	4.25	80	240
5	10	29.5	6	5.5	125	375
6	12	35.5	8	6.5	180	540
7	14	41.5	9	7.75	245	735
8	16	47.5	10	9.	320	960
9	18	53.5	11	10.25	405	1,215
10	20	59.5	12	11.50	500	1,500
11	22	65.5	13	12.75	605	1,815
12	24	71.5	14	14.	720	2,160

*Abstracted from a paper by Mr. Geo. S. Morison, presented at the New York meeting of the American Society of Mechanical Engineers.

In discussing the bearing Mr. Morison says:

It is possible that instead of a square bearing plate with two cylindrical surfaces of equal radii (my practice being to make this radius equal to the side of the plate) it would be better to use an oblong plate with different radii at bottom and top, but the only advantage of this would be that it would reduce the bending strain on the steel castings. Except for this I do not now think of any desirable improvement.

It may be objected that this rocker plate arrangement, which allows a motion in both directions, deprives the end post of a bridge of the transverse rigidity which is due to the usual square bearings. This objection is undoubtedly well taken, and the end posts must either be made stiff enough to resist lateral strains without the aid of square ends, or the two end posts should be rigidly connected by a floor beam or cross frame at the bottom. This latter I regard as the best practice, and think that it should always be followed in all important structures. The rigid connection, however, ought not to be made until the entire structure is completed and swung, so that the rocker plates have been free to move, and so distribute the weights equally on the bearing below; after this has once occurred, irregularities of workmanship will be so largely taken out that any subsequent motion will be too small to be disturbed materially by the stiff connections above.



MORISON'S STANDARD EXPANSION BEARING FOR BRIDGES.

Contrary to my usual practice, I have patented this arrangement, the patent being dated Oct. 25, 1892. The patent, however, was taken more for purposes of protection than with the expectation of deriving any revenue from it, and all bridge builders, railroads and other parties desiring to use this form of bearing may have the privilege of doing so on the payment of a very small royalty.

The American practice has generally been to make the permissible weight per lineal inch of the roller proportional to the square root of the diameter of the roller. A common provision in specifications limits the weight in pounds to $500\sqrt{d}$, d being the diameter of the roller. This rule is based on the theory that there is a permissible limit of indentation, which the roller may be allowed to make in the rolling surface, which permissible indentation is supposed not to exceed the elastic limit. If the versed sine of the indentation is constant, the chord of the same indentation will vary as the square root of the radius of the circle; and as the permissible weight is supposed to be a constant of the chord of indentation, which chord varies as the square root of the radius or diameter, the strain is determined accordingly.

While mathematically correct, this rule seems to me based on an incorrect conception of the function of rollers. There is no special reason why the strains either on the surface of the rollers or on the bearing surface should be kept within the elastic limit; on the other hand, it would be better to have them exceed the elastic limit, if the result of such excess was to reduce the surfaces both of the rollers and the bearing plates to the condition of the surface of cold rolled iron. The only necessary limit is that the elastic limit must not be so greatly exceeded that the metal under the surface will flow, and the roller become permanently deformed, as has occurred in conical roller bearings under turntable centers.

On the other hand, the same absolute indentation which would lock a small roller so that it would lie stationary in a groove might do little harm to a large roller. If we assume the roller to be set in a groove, we have forces applied on a bent lever tending to lift that roller out of the groove, the vertical arm of the bent lever being the radius of the roller, and the horizontal arm half the width of the groove. So long as the width and depth of the groove are kept proportionate to the radius or diameter of the roller, the force required to roll the roller out of the groove will be constant. In other words, the formula which will maintain for all sizes of rollers a constant freedom of motion would make the strains on those rollers proportional to their diameters.

In Germany this rule has been followed, and while there has been a considerable variation in the unit strain allowed, the fact has been accepted that the weight placed on a roller should vary directly as the diameter of the roller.

The American rule is not only incorrect in principle but vicious in its results. It encourages small instead of large rollers, a 12-in. roller, for example, being allowed to carry only twice the weight that would be put on a 3-in. roller, so that the smaller the diameter of the rollers the greater the weight which would be permitted on the same area of bearing surface.

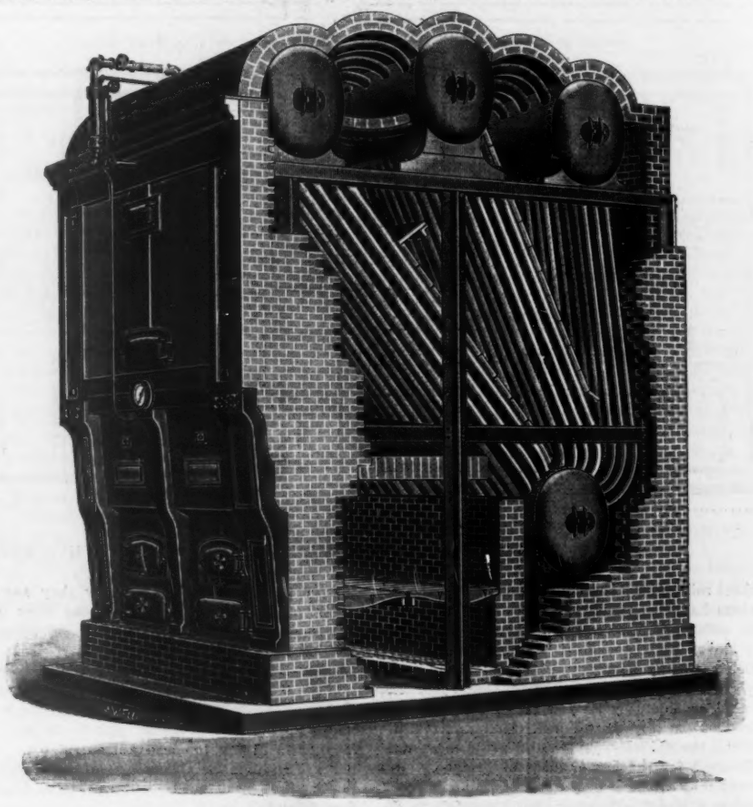
In proportioning expansion rollers, I have adopted a somewhat arbitrary basis, accepting $500\sqrt{d}$ as correct for a 4-in. roller, thus making the weight permissible per lineal inch 1,000 lbs. for a roller 4 ins. in diameter. Instead of varying the weight with the square root, I vary it with the diameter; this makes the permissible weight 250 lbs. per lin. in. on a 1-in. roller, and 3,000 lbs. per lineal inch on a 12-in. roller. The tabe of weights allowed on bearings of different sizes, which is shown in the table, has been calculated on this basis.

THE STIRLING WATER TUBE BOILERS AT THE COLUMBIAN EXPOSITION.

The water tube boiler has been rapidly gaining in favor during the past few years, especially since competition among the various manufacturers brought prices down to a point more nearly comparable with the prices of ordinary fire tube boilers than the prices which were asked a few years ago. A great variety of water tube or sectional boilers have been invented, and many of them have been actively pushed on the market; but for the most part the water tube boilers at present in use in stationary service conform to one general type, consisting of a nest of inclined tubes connected at each end to headers which extend upward to a horizontal water reservoir and steam chamber.

The only stationary water tube boiler which departs radically from this system of construction, and which has at the same time attained a widespread commercial success is the Stirling. A cross-section of a Stirling boiler is shown in the accompanying cut. The flame passes upward and backward along the front row of tubes to cross the first deflecting partition, then down through the second row, and around the lower edge of the second deflecting partition, then up around the rear nest of tubes to the uptake. The water circulation is upward in the front tubes, which are exposed to the hottest gases from the fire, downward in the middle nest of tubes, and downward also in the rear tubes, which act largely as feed water heaters, the feedwater being delivered into the rear drum.

The fact that water tube boilers were exclusively used in the steam power plant of the Columbian Exposition has called renewed public attention to their general merits, and seems likely to have much to do with bringing them into still more general favor. In our issue of April 13, 1893, we published a general description of this boiler plant, which included 23,000 HP., by eight different manufacturers.



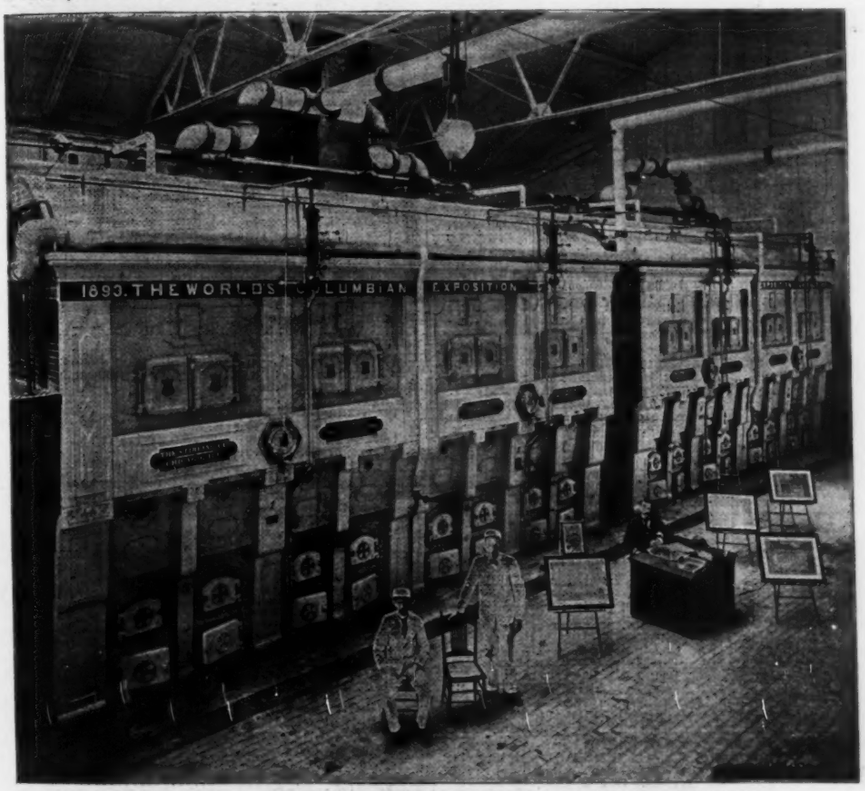
THE STIRLING WATER-TUBE BOILER.

Naturally much interest has been felt in the com-

parison which must inevitably be made between the different boilers thus put in service side by side. It was generally expected that a series of competitive evaporative tests would be made under the auspices of and at the expense of the Exposition authorities. As our readers know, the cloudy financial prospects for the Exposition during nearly its entire duration prevented its managers from appropriating funds to pay for competitive tests in any line of exhibits. In consequence each boiler exhibitor was asked to bear the expense of having a test made on his own plant, the report to be submitted to the jury of awards. We are informed that the Stirling Co. was the only firm which was willing to have tests made on this basis, and the plan was therefore abandoned.

In place of it, the water fed mto the boilers was measured by water meters, and a detailed log of the operation of each boiler was kept in which was noted every stoppage and its cause, and all repairs which were made and the nature and cause of the defect. The records of this six-months service are to be compiled in a report by Chief Engineer Chas. F. Foster. As the oil firing was a pretty severe test of the boilers, a good deal of interest is felt in the showing to be made in this report.

The Stirling Co. had in the main boiler-room four boilers of 450 HP. each. We show a perspective view of them herewith. Besides these boilers a battery of 900 HP. was installed in the Machinery Hall annex, and a 400-HP. boiler furnished steam to the Libby Glass Works on the Midway Plaisance, making a total of 3,100 HP. of Stirling boilers on the World's Fair grounds. We are informed that from the day these boilers were put in service until the close of the Exposition there were only two occasions when it became necessary to close down any one of the six boilers for any purpose whatever. The jury of awards commended the boilers for "economy in operation, accessibility for cleaning and examination, ability to handle impure feed water, absence of cast iron members, simplicity of construction and adaptability to at all times furnish dry steam."



STIRLING BOILERS IN POWER PLANT OF WORLD'S COLUMBIAN EXPOSITION.

Interlocking plant is being installed at all crossings on the Chicago Division of the Cleveland, Cincinnati, Chicago & St. Louis Ry., and track tanks are to be placed on the same division.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago—Existing Roads.

BALTIMORE BELT.—The Drake & Stratton Co., New York, has the contract for laying the rails for this road, and the Pencoyd Bridge Co., Philadelphia, that for the bridges at the street crossings.

BANGOR & PORTLAND.—Reports state that this railway may soon be extended from Nazareth, Pa., to Allentown. Pres. and Gen. Man., C. Miller, Bangor, Pa.

CENTRAL OF PENNSYLVANIA.—This road has been completed from Bellefonte, Pa., where it connects with the Pennsylvania, to a connection with the Beech Creek at Mill Hall. The line is nearly 30 miles long and will probably be opened for traffic this week. The construction has been done by the company, under the charge of J. W. Gephart, Bellefonte, Pa.

DELAWARE & HUDSON.—The J. & J. Rogers Co., Au Sable Forks, N. Y., is building an extension of the Plattsburg branch from Au Sable station to Au Sable Forks, a distance of 3½ miles.

FLINT & PERE MARQUETTE.—Press reports state that preparations are being made for changing the Sand Beach division, from Port Huron, Mich., to Sand Beach, 70¼ miles, to standard gage.

INTERCOLONIAL.—It is reported at Moncton, N. B., that the engineer's department has instructions to send men out surveying prospective branch lines for this railway with a view to promoting a canvass for the general elections which will be much sooner than is generally supposed.——A later dispatch from North Sydney, N. S., states that McKenzie and McCarthy, Engrs., have arrived to make preliminary surveys for a proposed 20-mile branch line.

PITTSBURG, M'KEESPORT & YOUGHIOGHENY.—A five-mile branch of this road was opened last week. It extends from Whitsell, Pa., to coal mines and coke works, passing through Perryopolis and up Washington Run.

PORTLAND & RUMFORD FALLS.—A contract for six stations on this road between Mechanic Falls, Me., and Auburn has been awarded to Murch & Arnold, Auburn, Me., the work to be completed by May 1, 1894.

Projects and Surveys.

COBURG, NORTHUMBERLAND & PACIFIC.—It is reported that arrangements have been completed with English capitalists for the construction of this railway. The line was surveyed last year from Coburg, Ont., northwest to a connection with the Canadian Pacific near Central Ontario Junction, a distance of 48 miles. The road will probably be operated by the Canadian Pacific. Ch. Engr., H. K. Wickstead, Coburg, Ont.

RESTIGOUCHE & VICTORIA.—The first 15 miles of this proposed road from Campbellton, N. B., will soon be ready for the contractors, according to reports. The construction will be easy.

WISCASSET & QUEBEC.—The town of China, Me., has voted to subscribe $15,000 in aid of this proposed railway, and it is claimed that over $100,000 has thus far been secured. The line projected is from Wiscasset, Me., to Burnham, about 50 miles, and China is the first town to vote on the question of aid.

Southern—Existing Roads.

FAIRMOUNT VALLEY.—Roane county, Tenn., recently voted to issue bonds for $100,000 to aid this proposed railway, according to press reports.

FLORIDA CENTRAL & PENINSULAR.—The first train on the Lake Charm extension of the East Florida & Atlantic passed over the line last week.——Local reports of the progress of the construction work on the Savannah extension state that all the track is now laid with the exception of about 17 miles on the northern end near the Altamaha River. This gap ought to be closed before Dec. 15, and it is not to be expected that the work will be delayed beyond that date. The extension is about 115 miles long and all the work has been done this year.

JACKSONVILLE, ST. AUGUSTINE & INDIAN RIVER.—This road has been opened for traffic to Sebastian, Fla., and the rails have been laid for about 10 miles south of that place. About 70 miles of track remains to be laid to reach Lake Worth, the projected southern terminus of the line, and it is hoped to reach that place by next Feb. 1.

TENNESSEE CENTRAL.—Roane county, Tenn., has voted to issue bonds for $150,000 in aid of this railway. Cumberland county recently voted $50,000 for this purpose, and it is claimed that the completion of the road is now insured from the terminus of the Nashville & Knoxville at Standing Stone to Rockwood, on the Cincinnati Southern, and thence to Knoxville by way of Harriman and Kingston.

Projects and Surveys.

BELINGTON & LITTLE LAUREL.—Incorporated at Harding, W. Va.; capital stock, $200,000; F. P. Rease, Belington; S. Sturmer, Fred. Weiscarger, Pittston, Pa.; Chas. Brandenburg, J. C. Wilson, Harding. It is proposed to build a railway from Belington to the head of the Little Laurel River, in Randolph county.

MOBILE & DAUPHIN ISLAND.—This company has filed a deed of trust to secure the payment of about $3,000,000 of bonds issued to build and equip its proposed road. The contract for the railway, 25 miles in length, is reported to have been awarded to Wm. A. Wolfe, New York, but it is stated that the bridge contract has not yet been awarded. Pres., Robt. Sewell, New York; Ch. Engr., T. M. Nicol, Mobile, Ala.

Northwest—Existing Roads.

BALTIMORE & OHIO.—A press dispatch states as follows: An extension of this railway is contemplated to Omaha, Neb. The Ohio & Mississippi Ry., owned and controlled by the Baltimore & Ohio, now ends at Beardstown, Ill., and it is proposed to extend it to Quincy, Ill., where connection will be made with the Quincy, Omaha & Kansas City, which ends at Trenton, Mo. This is to be extended 40 miles to Pattonsburg, Mo., where it will connect with the Omaha & St. Louis. J. F. Barnard, ex-president of the Ohio & Mississippi, is said to be organizing a company to put this scheme into action. It would be 150 miles shorter than any present route.

DULUTH & WINNIPEG.—It is stated that the proposed branch of this railway to the Diamond mine in Minnesota, 18 miles, will be built by the mine owners and not by the railway company.

INDIANA & ILLINOIS SOUTHERN.—This company will at once place 50,000 new ties and make other improvements to its roadbed. Gen. Man., P. H. Blue, Sullivan, Ind.

OMAHA BRIDGE & TERMINAL.—The bridge and terminal lines of this company were opened for business last week. The line connects at Council Bluffs, Ia., with the Eastern roads and work is being pushed to complete the line to South Omaha, Neb. The company was incorporated three years ago with a capital stock of $7,500,000, and up to date is reported to have spent $1,500,000. The construction has been almost continuously prosecuted since Oct. 1, 1892.

Projects and Surveys.

ST. JOSEPH, TARKIO & NORTHWESTERN.—Press reports state as follows: The directors of this company held a meeting at St. Joseph, Mo., Nov. 23, at which all arrangements for the construction of the road were completed. The line will be 205 miles in length, and will extend from St. Joseph by way of Tarkio, Mo., to Omaha, Neb. The money to insure the building of the road has already been provided for. Negotiations will at once be entered upon to secure the right of way over the route surveyed some time ago. Work upon the new road will commence as soon as possible. The directors of the company are David Rankin, W. F. Rankin and I. H. Prather, Tarkio, Mo.; C. R. Berry, St. Joseph, Mo.; Col. August Schuster, Savannah, Mo.; H. C. Keller, Leavenworth, Kan. The road is said to be in the interest of the Chicago Great Western.

TERRE HAUTE, OLNEY & CHESTER.—Incorporated in Illinois to construct a railway from a point on the Wabash River at or near York, Clark county, through the counties of Clark, Crawford, Jasper, Richland, Clay, Wayne, Marion and Jefferson to a point on the Mississippi River at or near Chester; principal office, Olney, Ill.; capital stock, $2,000,000; directors, T. A. Fritchey, Fred. N. Boyer, John N. Homer, Chas. Ferriman, Edmund C. Baughman, Robert N. Stotler

WISCONSIN & MICHIGAN.—Reports from Marrietta, Wis., state that the survey for this proposed road, noted in our issue of Oct. 26, is about completed.

Southwest—Existing Roads.

MISSOURI, KANSAS & TEXAS.—An official of this road is reported as stating last week that the survey from Lockhart, Tex., to San Antonio was practically completed and that the construction of the extension would soon be commenced; also that negotiations are now in progress for depot grounds at San Antonio.

TEXAS MIDLAND.—The citizens of Ennis, Tex., have voted the requisite tax to secure an extension of this road from Garrett south to that place, a distance of about five miles. Bids for this work are reported to have been opened.

Projects and Surveys.

BRAKENRIDGH LUMBER CO.—An enthusiastic meeting is reported to have been held at Greensburg, La., last week to consider the question of a railway from Springfield, La., to that place, in accordance with a proposition submitted by the Brakenridge Lumber Co., New Orleans. H. C. Newsom was president of the meeting.

PALESTINE & DALLAS.—O. P. Bowser, Alex. Sanger and Jas. Moroney have been appointed by the

Dallas, Tex., board of trade to confer with Burkett & Co., Palestine, Tex., with regard to this proposed railway. It is thought that the road will be an independent line with a connection with the Texas Trunk at Cedar or Kemp.

Rocky Mt. and Pacific—Existing Roads.

CANADIAN PACIFIC.—A press report states that about eight miles of track have been laid from Nakusp, B. C., eastward, and grading has been completed much farther on the Nakusp & Slocan line. Work will be resumed at the earliest possible date in the spring, so as to have trains running into the heart of the Slocan mining district not later than June. Some 1,200 men have been engaged on the work. Also that about six miles of track have been laid on the Revelstoke & Arrow Lake line and that about a mile of rails are now laid a day. It is intended to continue the construction all winter.

COLORADO MIDLAND.—The contract for the section between Midland, Colo., and Cripple Creek, nine miles, referred to last week, has been awarded to Clough & Davidson, according to press reports.

MONTANA SOUTHERN.—This company has been incorporated in Montana to build the railway projected as the Helena & South Mountain, as noted last week and in previous issues; capital stock, $1,500,000. The line is surveyed from Helena, Mont., east to Canyon Ferry at the Missouri River and from Whitehall to Laurin. The grading is nearly completed from Helena to Canyon Ferry, and from Whitehall 20 miles south. No tracks will be laid until next spring. The present contractors for grading are Brady & Davidson, Helena, Mont. Wooden bridges will be built at the two crossings of the Missouri River and one across the Jefferson River. The route of the road is from Helena, east to Canyon Ferry, and southeast by way of Townsend, Tosten, Whitehall, Twin Bridges, Sheridan, Laurin, to coalfields on the upper Ruby River, with branches from Laurin to Virginia City, Mont., and from Twin Bridges to Dillon. Arrangements are under way by which it is expected to push the work rapidly next spring to the coal mines. Pres., Samuel Word; Vice-Pres., R. A. Harlow; Ch. Engr., S. M. Kielland, all of Helena, Mont.; Treas., H. Elling, Virginia City, Mont.

Projects and Surveys.

BRITISH COLUMBIA SOUTHERN.—Reports state that 20 miles of this railway have been definitely located in East Kootenai. The line, as located, runs along the east side of Elk River to the confluence of Michel Creek, thence up the valley of Michel Creek. The company was chartered over a year ago to build a railway through Crow's Nest Pass, and received a land grant of 3,400,000 acres. If the road is built it will probably be done by the Canadian Pacific.

COLUMBIA RIVER & ASTORIA.—This company was incorporated several years ago to build a railway from Astoria, Ore., along the south bank of the Columbia River 60 miles to Goble, the terminus of the Northern Pacific. Several attempts have been made to secure the construction of the road, and a new proposition is now being considered by the citizens of Astoria. It is proposed to build the line between Astoria and Goble, 60 miles, to be completed before Jan. 1, 1895, and to purchase and complete the Seaside road into Astoria, reported as 22 miles long, by May 1, 1894. The charter of this company will be used, and W. H. Kennedy, Portland, has been retained as chief engineer. The line to Goble was located last year by Mr. Kennedy and about 20 miles of right of way secured. The proposition submitted includes a bonus of 3,000 acres of land and right of way 40 ft. wide through the entire water front of the city; the same to be decided upon favorably before Dec. 10, and the construction of the road to be commenced as soon as possible thereafter. J. C. Stanton and J. S. Smith, New York; Walter C. Smith and E. A. Seeley, Portland, Ore.

HUDSON BAY & PACIFIC.—Press reports state that the Hudson Bay & Pacific Ry. New Steamship Route Syndicate has been formed in England, with a capital stock of $50,000, to enter into an agreement with Joseph Nelson, and to obtain from the Dominion parliament of Canada the incorporation of a company, with the necessary concessions and powers, to construct and operate a railway from Port Churchill, on Hudson Bay, to a junction with the Canadian Pacific at Calgary, Alberta.

Foreign.

MEXICAN CENTRAL.—Press reports from the city of Mexico state that this company has let a contract of over $1,000,000 worth of wood, to be delivered in three years. The delivery of this wood involves the construction of a railway about 30 miles in length. The wood will be cut in the Jazmin Mountains and the deliveries are to be made at Cazadero, on the line of the Mexican Central Ry. A contract has also been awarded for 100,000 crossties, to be delivered to this line at Calays.

MEXICO.—It is reported that surveys have been commenced for a railway from Gomez Farias, on the Mexican National to Concepcion del Oro, Mex., a mining camp in the state of Zacatecas. The concession for this line, without subsidy, is granted to General Olivares, Monterey, and William Purcell, Saltillo, and calls for a road from some point on the Mexican National to a point on the Mexican International. The line will pass through the Lagma, the vine and cotton district of the state of Coahuila. The total length of the proposed road is about 124 miles, the length of that part now contemplated being about 44 miles.

RUSSIA.—A dispatch from London states as follows: The "United Service Gazette" gives prominence to an article saying that Russia has now decided to construct an open water port on the Murman coast of Russian Lapland, and that she will also build a railway which will connect this port with Uleaborg on the Gulf of Bothnia, and through Uleaborg with St. Petersburg. The "Gazette" says that it is impossible to exaggerate the importance of this move, and adds that the route of the proposed railway and the locality of the port have already been surveyed.

STREET RAILWAYS.

CONWAY, MASS.—Citizens of this place propose to incorporate the Conway Electric St. Ry. Co., capital stock, $50,000, the power to be derived from the Conway Gorge.

GARDNER, MASS.—M. A. Coolidge is reported as stating that over half of the $75,000 of stock for the proposed electric railway has been subscribed.

LOWELL, MASS.—It is stated that the street railway company will commence work in the spring on the extension to Chelmsford Center.

MARLBORO, MASS.—James F. Bigelow has finished the survey of the Pleasant St. route of the proposed street railway extension to Hudson.

BRIDGEPORT, CONN.—The Bridgeport Traction Co. has presented plans to the council for its proposed system of electric railways. The improvements are estimated to cost over $600,000 and the work will be commenced as soon as possible.

NEW HAVEN, CONN.—Subscriptions are being received for the stock of the Mfrs.' St. Ry. Co. The proposed road is from Grapstone Point to a connection with the Consolidated at Cedar Hill, and it is reported that the construction will be commenced in the spring. Geo. S. Barnum, F. L. Bigelow, S. J. Fox and W. W. Kendall are the incorporators.

BROOKLYN, N. Y.—It is claimed that the Brooklyn, Queens County & Suburban R. R. Co., noted last week, has been incorporated to consolidate all the street railways of this city; capital stock, $15,000,000; Pres., H. E. Hutchinson; Secy., Henry T. Bragg, Yonkers; Treas., Frank Bailey, Brooklyn.—The Brooklyn City R. R. will extend its tracks to Flushing, according to reports.

CARLISLE, PA.—The town council has granted a franchise to the Cumberland Valley Electric Ry. Co. for a line through this place.

ERIE, PA.—Maj. Hoyt is reported as stating that the right of way for the Erie & Edinboro Electric Ry. has all been secured except through Millcreek, and that the road will be built as soon as possible.

HOMESTEAD, PA.—The Homestead St. Ry. Co. was incorporated Nov. 29 to build an electric railway five miles long between this place and Pittsburg; capital stock, $30,000; Pres., John C. Whitla, Beaver Falls, Pa.

READING, PA.—It is estimated that the cost of extending the Reading & Southwestern Electric Ry. from Mohnsville, this county, to Adamstown, Lancaster county, a distance of nine miles, would be $50,000. In case the Adamstown people subscribe half this sum the road will probably be built. Subscription books are now out. The road already extends from this city to Mohnsville, and committees have been appointed to secure funds for this proposed extension.

SOUTH BETHLEHEM, PA.—The board of trade of Heliertown has appointed Jere S. Hess and Dr. H. D. Heller members of a committee to confer with a committee from this place with a view to securing the construction of the projected electric railway between the two places.

KNOXVILLE, TENN.—Chas. J. Pogue and associates have been granted an extension of 90 days in which to begin work upon the proposed electric street railway.

CINCINNATI, O.—The Cincinnati St. Ry. Co. will receive bids until Dec. 28 for 12 boilers of the water tube type, each boiler having not less than 3,600 sq. ft. heating surface; eight automatic cut-off engines of 800 H.P. capacity each; eight multipolar electric railway generators of 500 K-W. capacity each. Specifications on file in the office of Bert L. Baldwin, Mech. Engr., 227 Main St.

CLEVELAND, O.—It is reported that plans are being prepared for an electric railway to Chardon and Burton in Geauga county.

FOSTORIA, O.—A press report states that the Tiffin-Fostoria Electric Ry., 12 miles long, is to be completed at once. The work was started several months ago, but the money stringency stopped operations. The bonds have since been sold, and the work will now be pushed. It is the intention to have the line in operation by Decoration Day.

INDIANAPOLIS, IND.—The Indianapolis & Broad Ripple R. R. Co. has been incorporated to build a double-track electric railway between this city and Broad Ripple; capital stock, $50,000; R. T. McDonald, Fort Wayne; R. W. Clay, Philadelphia; R. C. Light, Broad Ripple.

ST. JOSEPH, MICH.—The city council has granted a franchise to the St. Joseph & Lake Shore Ry. Co. and the St. Joseph Electric Light & Power Co. to construct an electric railway from the center of the city to the southern limits and to furnish electric power and light, according to reports. The company is composed of Chicago capitalists and the railway and light plants are to be in operation by Aug. 1, 1894.

WHITEFISH BAY, WIS.—The Whitefish Bay & Milwaukee Rapid Transit Co. has been incorporated to operate a street railway in Milwaukee county; capital stock, $15,000. F. G. Isenring, T. W. Williams, A. F. Remington, A. F. Vussbaumer, H. K. Curtis, F. A. Putnam and G. A. Rogers. It is reported that the company will lease the Milwaukee & Whitefish Bay line, which will be improved and the fare reduced to 5 cts.

VALLEY JUNCTION, IA.—J. S. Polk, Des Moines, is reported as selecting a route for a proposed electric railway between this city and Des Moines.

DULUTH, MINN.—The City Ry. Co. has been incorporated to build and operate a line of street railways in St. Louis county, Minn., and Douglas county, Wis.; capital stock, $600,000; Pres., Andrew H. Burke; Treas., Henry G. Harris. The council of West Duluth has granted a franchise to the company and others will be petitioned for.

ST. LOUIS, MO.—The People's R. R. Co. proposes to issue $150,000 of bonds to change the motive power of one of its lines to electricity.

LOS ANGELES, CAL.—It is stated that $850,000 of bonds have already been negotiated for the construction of a double-track electric railway between this city and Pasadena, a distance of 30 miles. The company is now being organized to build the road. C. W. Stewarts, Col. L. P. Crane, W. H. Knight and H. D. Underwood are among those said to be interested.

ONTARIO, CAL.—The Ontario & San Antonio Heights Ry. Co. has made a proposition to change the motive power of its road to electricity and put in an electric light plant.

SALT LAKE CITY, UTAH.—The Big Cottonwood Power & Water Co. has been incorporated to utilize the power of Big Cottonwood Creek, and a franchise has been granted the company for an electric railway in this city and to the mouth of the canyon; capital stock, $1,000,000; Pres., J. W. Donnellan; Secy., G. M. Cannon; Treas., G. M. Downey.

BRANTFORD, ONT.—The board of trade is investigating the scheme for an electric railway between this city and Selkirk.

HALIFAX, N. S.—F. W. W. Doane, Cy. Engr., has presented a long report recommending the use of the overhead trolley system in this city.

ELEVATED RAILWAYS.

CHICAGO, ILL.—The Central Construction Co. has been organized to build a downtown belt of elevated railway to connect the existing systems and several of the important railway stations; capital stock, $50,000; directors, O. F. Aldis, Chas. N. Fay, B. A. Eikhart, H. B. Hurd, W. E. Hale, E. S. Pike and C. N. Morse.——The Northwestern Elevated Ry. Co. was recently incorporated with a capital stock of $15,000,000, as stated Nov. 16, and the city council is now considering an ordinance granting it a franchise for a main line and four branch lines on the North Side.—The president of the Lake St. road is reported as stating concerning the Halsted St. extension that the work will probably be begun on that branch at once. Of course the road may not be built at once. Not even the iron structures have been ordered yet. Ground may not be broken before next spring. The route will have to be surveyed and the condemnations acquired. Surveyor Sloan of the Lake St. road will have charge of this preliminary work. It is intended to extend the branch eventually to Englewood, but it will probably not go much farther than the river at first. The branch may not be finished for a year yet.

HIGHWAYS.

MISSOURI.—A meeting of the citizens of Leavenworth county, Kan., and Platte county, Mo., was held at Farley, Mo., last week to consider the construction of a macadamized highway from the Bluff road, between Farley and Platte City, and the new steel bridge, a distance of 2½ miles; estimated cost, $10,000. A. L. Banning, Chn. meeting; J. Wallace, Chn. Com.

TEXAS.—A press report from Wharton, Tex., states that R. F. Bentley, Co. Judge, has advertised for bids for the building of a public highway, to be 40 ft. wide, from the west side of the Colorado River opposite that city to El Campo. The total length will be about 12 miles, and the contract will include several small bridges over sloughs. This road is intended as an adjunct to the new $18,000 bridge, which will be completed next year.

WASHINGTON.—The lowest bid for the construction of the Northwest Diagonal road from the city limits of New Whatcom to Ferndale, seven miles, was that of Moran & Singleton, at about $20,000. This is the first highway work to be done in that part of the state under the new law.

BRIDGES AND TUNNELS.

MAINE.—It is reported that the Maine Central will erect new steel bridges at the following places during the coming year: Topsham bridge over the Androscoggin at Brunswick, on the main line; over the Kennebec at Waterville; Ticonic bridge over the Kennebec at Waterville, and the two west spans of Lewiston bridge over the Androscoggin at Lewiston. Topsham bridge will have four spans, length 730 ft. 5 ins.; Ticonic bridge, four spans, length 628 ft.; Lewiston bridge, two spans, length 317 ft. 2 ins.

PITTSBURG, PA.—The Spruce Run Bridge Co. has been incorporated to build a bridge across Spruce Run; capital stock, $600; T. R. Pittock, Dixmont; John Crossett, Glenfield.

SCRANTON, PA.—The city engineer has received bids for an iron viaduct on West Lackawanna Ave. between Scranton and Ninth Sts., the prices ranging from $20,000 to $35,000, according to reports. The cost of the viaduct will be borne equally by the Delaware, Lackawanna & Western R. R. Co., whose tracks it will cross with a continuous span of 125 ft., the Scranton Traction Co. and the city.

BALTIMORE, MD.—Bids were opened last week for a bridge on the Maryland Ave. over Jones Falls. The bridge will be a one-span iron and steel bridge, similar in design to the spans constructed by the Pennsylvania R. R. Co. across its tracks north of the proposed bridge. The bids were as follows: Pennsylvania Steel Co., $13,489; Edge Moor Bridge Works, $14,400; H. A. Ramsay, agent, $15,394; Campbell & Zell Co., $16,005; Pennsylvania Bridge Co., $17,332; Pencoyd Iron Works, $17,615; G. W. Drury, agent, $18,200; New Jersey Steel & Iron Co., $18,554; King Bridge Co., $18,781; Berlin Iron Bridge Co., $19,300.

BELLEFONTAINE, O.—The county commissioners will receive bids until Dec. 21 for the construction of a bridge over the Miami River about five miles north of De Graff. The bridge will have one span of 150 ft. on stone abutments, or one channel span of 80 ft. and two approach spans of 40 ft. each on iron piles; roadway, 16 ft.; also bids for stone abutments for the 150-ft. span. Chas. D. Campbell, Co. Aud.

MILWAUKEE, WIS.—The following bids have been received for the superstructure of the new Sixteenth St. viaduct:

King Bridge Co., Cleveland	$250,463
American Bridge Wks., Chicago, $217,500 and	228,000
Elmira Bridge Co., Elmira, N. Y., $242,200 and	231,200
Detroit Bridge & Iron Works, Detroit	182,279
C. L. Strobel, Chicago, $185,000, $186,000, $187,000	182,000
Chicago Bridge & Iron Co., Chicago	248,794
Pittsburg Bridge Co., Pittsburg, $237,500 and	240,300
New Jersey Steel & Iron Co., Trenton, N. J.	272,900
Phoenix Bridge Co., Philadelphia	221,880
A. & P. Roberts & Co., Philadelphia	258,280
Theodore Kandler, Chicago	274,000
Edge Moor Bridge Works, Wilmington, Del., eight designs, $187,900 to	196,400
Illinois Steel Co., Milwaukee	254,445
Wisconsin Bridge & Iron Co., Milwaukee, $223,344.55 and	224,000
R. G. Wagner, Milwaukee, 12 designs, $202,101 to	246,746
T. R. Bentley, Milwaukee, $245,700, $235,700 and	237,700

SHERMAN, TEX.—The commissioners' court of Grayson county will receive bids until Dec. 12 for the erection of a bridge on Bois d'Arc Creek, near Whitewright; span, 74 ft.; depth of creek, 16 ft. E. P. Gregg, Co. Judge; T. W. Hudson, Clk.

MONCTON, N. B.—Bids are asked until Dec. 28 for the construction of a steel through bridge of five spans over the Narrows, Halifax Harbor, N. S., including piers and abutments containing about 6,000 cu. yds. of ashlar masonry and about 1,000 cu. yds. of concrete.

Three of the spans are 260 ft. and two 100 ft. Four of the piers are in tidal water from 65 to 85 ft. in depth. D. Pottinger, Gen. Man. Intercolonial Ry.

PORT STANLEY, ONT.—It is reported that the contract will be awarded this month for an iron and steel bridge to replace the Port Stanley bridge. The new structure will have two 110-ft. spans and a 16-ft. roadway.

WATER-WORKS.

BATH, ME.—The citizens have voted to ratify the action of the council permitting the Maine Water Co. to change the source of supply to Nequasset Lake.

ESSEX JUNCTION, VT.—A village meeting was held last week to consider the question of a supply. Considerable property has recently been destroyed by fire.

BELCHERTOWN, MASS.—G. W. Longley, Tn. Clk., is a member of a committee to secure a supply for fire protection. It is reported that an engineer will be employed at once.

CAMBRIDGE, MASS.—Hiram Nevons, Supt. writes us that the council contemplates building a large storage reservoir in the Stoney Brook water shed; also reservoir in Belmont of about 40,000,000 gallons capacity. Bids will probably be asked for a 20,000,000-gallon high duty pumping engine, 700 tons pipe for distribution system and four miles of 40-in. force and supply main.

BROCKTON, MASS.—The water board has voted to advertise for bids for 14,000 tons 24-in. cast iron pipe and 130 tons 30-in. pipe for the new main.

FITCHBURG, MASS.—The city treasurer has been authorized to issue $25,000 of 4% 10-year water bonds.

HOLYOKE, MASS.—W. E. McClintock, Boston, has recommended a supply from Munn's Brook, in Granville, with a 20 or 24-in. main to Ashley Pond, 11¼ miles; estimated cost of dam, $4,000, and of main, $226,000.

MEDFORD, MASS.—The aldermen have appropriated $18,000 for a water purification plant.—A contract for pipe has been awarded to R. D. Wood & Co., Philadelphia, at $6,600, the McNeil Pipe & Foundry Co., Burlington, N. J., bidding $6,900 and the Warren Foundry & Machine Co, Phillipsburg, N. J., $7,110.

NEW BEDFORD, MASS.—R. P. C. Coggeshall, Supt., informs us concerning the proposed new supply, estimated to cost $1,125,900, noted last week, that if the necessary authority is obtained from the legislature this winter the city may be able to commence work in a year, but not in less time.

NORTHAMPTON, MASS.—It is reported that work will soon be commenced on a new storage reservoir.

QUINCY, MASS.—The committee has recommended that $30,000 be appropriated for extension of the mains.—An election was held Dec. 5 to vote on the question of a supply from Blue Hill River as authorized by the last legislature.

UXBRIDGE, MASS.—The legislature will be petitioned for authority to take a supply from Meudon Pond.

FOSTER CENTRE, R. I.—Surveys are being made for a proposed new reservoir near this place.

NEWTOWN, N. Y.—The Newtown Water-Works Co. has awarded a contract for a stand-pipe and is reported as about to contract for pipe for its new works at Maspeth.

DECKERTOWN, N. J.—Jos. B. Rider, Norwalk, Conn., has reported that there are 10 places available for a supply; estimated cost of works, $25,000 to $40,000.

ALLEGHENY, PA.—Julian Kennedy, Engr., has decided in favor of a supply from Nine-Mile Island, according to reports; estimated cost, about $1,900,000.

ALTOONA, PA.—The council has not yet awarded the contract for the impounding reservoir at Kittanning Point, and considerable opposition to the project is now developing, so that the reservoir may not be built at all. Bids for the work have been received three times, as previously stated in these columns.

BENNETT, PA.—The recent bond issue of $80,000 by the borough of Millvale has been declared legal and the works will probably be put in as soon as possible.

DU BOIS, PA.—It is reported that the water company has spent $10,000 to secure an adequate supply and has not yet succeeded.

LANCASTER, PA.—The committee has decided to ask for bids for building an additional 25 ft. to the stand-pipe.

LIGONIER, PA.—The citizens have voted in favor of the proposed works.

QUAKERSTOWN, PA.—A private company is preparing to secure a gravity supply, according to reports. There will be about five miles of pipe.

HYATTSVILLE, MD.—The citizens are discussing the question of works and other improvements.

NORFOLK, VA.—The commissioners will receive bids until Dec. 9 for a 100-HP. boiler.

MOUNDSVILLE, W. VA.—A franchise has been granted to Col. Ben Wilson, Clarksburg, and J. F. Fawcett and C. W. Pool, Pittsburg. The works will cost $75,000 to $100,000, and the construction must be commenced within 60 days, according to reports.

WESTON, W. VA.—The citizens are discussing the question of works.

AUGUSTA, GA.—The mayor has ordered 40 meters to be placed where water is to be used for power.—The Hill residents are reported as to hold an election soon to vote on the question of a supply.

COLUMBUS, GA.—B. M. Hall, Atlanta, has been engaged to make plans for works to be owned by the city. The present works were built in 1882 by the Columbus Water-Works Co.

JACKSONVILLE, FLA.—Wm. C. West, Cy. Recorder, writes us that active steps will not be taken for extension or improvement until the supreme court has declared legal the $1,000,000 bond issue, recently voted.

SCRANTON, MISS.—It is reported that an election will be held to vote on the question of works. An artesian supply was secured by F. H. Lewis about two years ago for domestic use only.

HUMBOLDT, TENN.—E. W. Jug, mayor, writes us that the proposition for works and electric lights will be voted upon at an election Dec. 7.

CYNTHIANA, KY.—Plans for the proposed works are being prepared by C. C. Breed, Louisville, after which bids will be asked for the construction; estimated cost, about $40,000.

CINCINNATI, O.—The park commissioners will receive bids until Dec. 11 for 1,902 ft. 6-in. cast iron pipe, 9,180 ft. 4-in. and 4,000 lbs. special castings.

CLEVELAND, O.—Bids are asked until Dec. 22 for 3,250 ½ to 1-in. brass corporation cocks, and the same quantity of brass stop cocks. J. H. Farley, Dir. Pub. Wks.

COLUMBUS, O.—The council has voted to purchase a water tower, to cost $4,500.

WINTON PLACE, O.—An election will be held Dec. 30 to vote on an issue of bonds for $25,000 for works.

EVANSVILLE, IND.—The secretary has been instructed to obtain prices for new boilers.—The superintendent has submitted a proposition for four miles of new mains.

NORTH MANCHESTER, IND.—The council has sold the $22,000 of water bonds voted last spring, and work on the plant will be commenced at once.

ROCHESTER, IND.—Bonds for works have been sold and the contract for the construction is about to be awarded, according to reports.

BAD AXE, MICH.—J. M. Donaldson, Vil. Clk., writes us that the contract for works has been awarded to the Michigan Pipe Co., Bay City, and that the construction will be commenced in the spring.

LANSING, MICH.—The council has authorized the purchase of a 5,000,000-gallon Worthington pump, which was at the World's Fair, at $16,500, it is reported.

MARSHALL, MICH.—An election was called for Dec. 5 to vote on an issue of bonds for $40,000 for municipal works. Works were built here several years ago by the Marshall Water-Works Co., but the supply is claimed to be insufficient.

BATAVIA, ILL.—The citizens have voted, 422 to 110, to issue bonds and to put in works.

BEMENT, ILL.—The proposition to issue bonds for works was recently defeated by a small vote.

JACKSONVILLE, ILL.—Fred Davenport, Cy. Engr., writes us that no plans have been adopted for increasing the supply, but that surveys are now being made for a new reservoir near the present pumping station, and that a few hundred feet of iron pipe would be the only addition necessary to the works. There has been talk of selling the plant, as noted last week.

OTTAWA, ILL.—The Columbia Water-Works Co. has been incorporated by T. D. Catlin, W. C. Rale and others. The capital stock is $5,000, and it is proposed to have 500 stockholders of $10 each. The city has voted to issue $60,000 of 5½% bonds, its limit under present assessed valuation, and the company will issue $100,000 of 6% 20-year bonds, according to reports, all of which have been negotiated. The works will be put in as soon as possible.

PANA, ILL.—A. B. McMillen, Cy. Clk., writes us that the specifications for works have not yet been prepared.

ROCKFORD, ILL.—A press report states that the council is considering plans for increasing the supply, at an estimated cost of $50,000.

WAYNESVILLE, ILL.—It is reported that works will be put in.

RIPON, WIS.—The Ripon Water Co. has increased its capital stock from $80,000 to $100,00.

OTO, IA.—The question of works is being discussed.

DULUTH, MINN.—The council has voted unanimously in favor of issuing $800,000 of bonds for the proposed new works, and it is hoped to spend $200,000 of the money this winter.

MINNEAPOLIS, MINN.—F. W. Cappelen, Cy. Engr., informs us that the following bids were received for 400 ft. of 5-ft. steel intake, with 20 × 50 × 22 ft. wooden crib, for the North Side pumping station, all bidders but one being residents of this city: Rinker & Hoff, $11,891; Ed. T. Sykes, $8,450; Heidenreich Co., Chicago, $17,800; J. J. Gleason, $7,800; John Burns, $8,633; Tobin & Gleason, $9,700; D. D. Smith, $9,160.

AUBURN, NEB.—C. O. Snow, Cy. Clk., informs us that an election will probably be called soon to vote on an issue of bonds for $20,000, of which $18,500 would be for works and $1,500 for two fire engines.

BLOOMFIELD, NEB.—The "Monitor" is urging the necessity of works.

DELL RAPIDS, S. DAK.—The council is considering the question of works, according to reports.

WOONSOCKET, S. DAK.—Contracts for extensions have been awarded to Frank Campbell, J. E. Carpenter and Peter McLean (2).

CLINTON, MO.—The Home Water-Works Co. is about ready to award contracts for a new reservoir, 20 × 110-ft. stand-pipe, pump, hydrants, new mains and extensions to old, and new boiler house. We are informed that the old works will be entirely rebuilt; population, 6,000. Engr., E. H. Burlingame, Providence, R. I.

KANSAS CITY, MO.—The city engineer has been directed to ascertain the cost of the right of way for a pipe line from the proposed supply plant and settling basin, two miles above Harlem, to a point on the Missouri River opposite Broadway.

ST. CHARLES, MO.—The Water & Improvement Co. has been incorporated by H. O. Scott, Thos. Fox and I. K. Lionberger; capital stock, $100,000.

LITTLE ROCK, ARK.—The city clerk informs us that the works at North Little Rock will be an extension of the plant of the Home Water-Works Co., which supplies this city.

BEEVILLE, TEX.—The Beeville Water Co. has been incorporated by Robt. Law, J. C. Crisp, F. S. Taylor, G. W. Greathouse and C. P. Edison; capital stock, $25,000. The contract for works was noted last week.

NORMAN, OKLA.—It is reported that works will probably be put in.

GLOBEVILLE, COLO.—An election will be held Dec. 30 to vote on an issue of bonds for $40,000 for works. It is proposed to pump the supply from artesian wells to a stand-pipe. Alfred Williams, 3,315 Humboldt St., Denver, is town engineer.

MIDLAND, COLO.—The Midland Land & Water Co. has been incorporated and is reported as about to contract for a reservoir and works; capital stock, $100,000; Pres. and Gen. Man., J. B. Porter, Denver.

OAKESDALE, WASH.—J. W. Johnson, Cy. Clk., writes us that bids will probably be asked in early spring for a gravity system of works; population, 1,800; Engr., A. W. D. Lewis, Moscow, Idaho.

SIDNEY, WASH.—Alex. Patterson, Tn. Clk., writes us that the contract for works estimated to cost $3,500 will probably be awarded about Jan. 1. An artesian supply will be secured. The well may be located near Black Jack Creek and the supply raised to the reservoir by means of the water power from the creek. The citizens voted, 55 to 4, to issue bonds for $5,000; population, 650.

SPOKANE, WASH.—The mayor has proposed that all bids for the new works be rejected and that the conduit be built this winter by the city. Mr. Martin, the lowest bidder, has withdrawn his bid for the work.

SUMNER, WASH.—L. R. Coombs, Tn. Clk., informs us that Ogden & Bosworth, Tacoma, have prepared plans for new works to be owned by the town, but that the Spring Beach Water Co., which built works here in 1887, has secured an injunction to prevent the construction. The question will be decided in about three months.

TACOMA, WASH.—Surveys are being made for a supply from Maplewood Springs, near Puyallup, where it is proposed to build a reservoir and put in a pumping plant.

HILLSBORO, ORE.—H. V. Gates, Pres., informs us that the Hillsboro Electric Light & Water Co., recently incorporated, has absorbed the old water and light plants known as the Hillsboro Light & Water Co. and Rankin & Gates.

VANCOUVER, B. C.—The committee has decided to award a contract for a reservoir in Stanley Park, to cost $25,000.

HAMILTON, ONT.—The engineer has recommended an appropriation of $10,000 for meters next year.

LONDON, ONT.—The commissioners have decided to ask for $75,000 for a new 18-in. main and $125,000 for improvements, including two 3,000,000-gallon pumps, one a steam pump and the other to be run by water power, and $40,000 for extensions of mains. John M. Moore, Engr. and Supt.

AYLMER, QUE.—J. T. Whelan, Secy.-Treas., informs us that an exclusive franchise for 25 years was recently granted to the Perry Co., who have agreed to furnish 35 fire hydrants to the town for $800 per year, but that no further action has been taken.

ARTESIAN WELLS.

MILLER, S. DAK.—A special election was recently held to vote on an issue of bonds for an artesian well.

IRRIGATION.

SAN FRANCISCO, CAL.—Press reports state that the Colorado Irrigating Co. has projected a canal to irrigate 1,200,000 acres of land in the Salton Desert. Should the tract in question be irrigated its value would be from $10,000,000 to $20,000,000. The total length of the canal will be about 400 miles, and the estimated cost is nearly $5,000,000.

SEWERS.

FORT FAIRFIELD, ME.—The citizens are reported as discussing the questions of sewerage and street improvements.

NEWPORT, N. H.—E. Gustine & Son, Keene, have made surveys for the proposed sewers, which will probably be over six miles in length with outlets into the river. Mr. Gustine informs us that the estimates have not yet been completed, and that the town will probably vote on the question of construction at the town meeting in March.

ROCHESTER, N. H.—Chas. W. Brown, Cy. Clk., writes us that the system is about completed and that the outlet will probably be established by spring.

BROCKTON, MASS.—The commissioners have been authorized to contract for the construction of the Crescent school and Center St. systems next year; estimated cost, $100,000.—Bids are asked until Dec. 18 for a quantity of sewer pipe, as stated in our advertising columns. F. Herbert Snow, Cy. Engr.

BUFFALO, N. Y.—The department of public works will receive bids until Dec. 21 for brick and tile sewers.

JAMESTOWN, N. Y.—It is reported that bids will soon be asked for additional work to be done next season.

ROCHESTER, N. Y.—The East Side trunk sewer commission will receive bids until Dec. 8 for the construction of the University Ave. overflow outlet sewer.—The contract for the State St. stone sewer was awarded to Chambers & Casey, at $20,465; estimate, $22,300.

MILLVILLE, N. J.—The council has passed an ordinance granting a franchise to the Millville Sewerage Co. The company is to lay about 10 miles of sewer pipe and have an exclusive franchise for 50 years, with the proviso that the city can purchase the plant at the expiration of 10 years by paying the cost price and the cost of maintenance and dividends at the rate of 10% per year. Much opposition to this is reported, and should the ordinance be signed by the mayor an injunction would probably be asked for.

SOUTH ORANGE, N. J.—The committee is considering a proposition approved by the trustees for a joint sewer system to be constructed for the benefit of this village, Millburn, Short Hills and Wyoming, the other villages to be given the free use of the disposal works for five years.

ERIE, PA.—The city engineer will receive bids until Dec. 14 for sewers in four streets.

PHILADELPHIA, PA.—Bids are asked until Dec. 11 for supplies and work during 1894, including the repairing of sewers and constructing of wooden trunk drains. Jas. H. Windrim, Dir. Pub. Wks.

HYATTSVILLE, MD.—The citizens are considering the question of issuing bonds for $50,000 for sewers and other improvements.

MANCHESTER, VA.—John C. Robertson has submitted a proposition for putting in a system.

HAMILTON, O.—Plans are being prepared for a complete system, according to reports.

NILES, O.—Press reports state that the city will purchase material and commence the construction of the proposed system at once, for which plans have been prepared by Alexander Potter, New York.

SPRINGFIELD, O.—Concerning the proposed intercepting sewer, recently noted, D. F. Snyder, Asst. Cy.

Engr., writes us that only the preliminary line has been run and that most of the right of way is yet to be secured. The size of sewer has not been fully determined.

TIFFIN, O.—The city clerk has been directed to advertise for bids for sewers in Clay St.

BRIGHTWOOD, IND.—Bids are being received for constructing a system, according to reports.

INDIANAPOLIS, IND.—The board of public works will receive bids until Dec. 11 for main and local sewers.——The following bids were received Nov. 29 for a local sewer: A. Bruner, $4.75 per lin. ft.; Mansfield & Allen, $4.49; Fries, Barr & Co., $4.24; William Bosser?, $4.12; Daniel Foley, $4; Gansberg & Roney, $3.97; T. T. Sheehan, $3.70; Roney & Spaulding, $3.50; Fulmer, Seibert & Co., $3.58, awarded contract.

PONTIAC, MICH.—The citizens have voted in favor of the proposed issue of bonds for $25,000. Consult. Engr., Chas. E. Green, Ann Arbor.

ST. JOHNS, MICH.—Plans for a separate system of sewers have been prepared by W. L. Stebbings, Consult. Engr., Monadnock Bldg., Chicago. Bids will probably not be asked for until spring.

MOLINE, ILL.—The contract for the Second St. storm water sewer has been awarded to J. L. Huey & Co., at $3.70 per lin. ft., the other bids being: J. A. Pettifer, $7; Gust Ed. $4.20; Mordhorst & Kuhl, $4.55; Hammerquist & Smith, $4.00; Pierce & Lunquist, $3.95.

APPLETON, WIS.—The city engineer is preparing plans for a sewer in Ward 5.

BOONE, IA.—The council has voted to receive bids for sewers in that part of the city east of Division St., the work to be completed by Jan. 1, 1896.

SPRINGFIELD, MO.—Contracts have been awarded as follows: Springfield Plumbing Co., at $7,586; S. W. Laughlin, at $5,924; E. Plummer, at $2,696.

SALT LAKE CITY, UTAH.—The "Tribune" prints the following concerning the act of the council in canceling the contract for the gravity sewer: About $200,000 has been expended on the gravity sewer, and the opinion is expressed, by those supposed to know whereof they speak, that it will be at least three years before the city will be able to again resume work on it in earnest. In order to close it down for the winter, as the program now is, about $16,000 will have to be expended, and when that work is completed, all the city will have to show is a conduit about two miles long without an available inlet or outlet. It will require at least $200,000 more to finish the job, and the cost of connecting the laterals will involve an expense of at least $100,000 more.

STREETS.

ROCHESTER, N. Y.—The contract for paving East and West Main St. with Medina stone blocks has been awarded to Whitmore, Rauber & Vicinus, at $92,897. R. Y. McConnel bid $87,438; Bruff, Horn & Co., $88,021, and Lauer & Hagaman, $92,153; engineer's estimate, $90,000.

ERIE, PA.—The council is considering resolutions for over two miles of paving to be done next season.

PHILADELPHIA, PA.—Bids are asked until Dec. 11 for material, supplies and work during 1894, including the following: Repairing paved streets, furnishing crossing and gutter stones, maintenance of unpaved and macadamized streets, furnishing broken stone and grading streets. Jas. H. Windrim, Dir. Pub. Wks.

PLEASANT RIDGE, O.—The following bids were received by J. M. Harper, Engr., for curbing, guttering and macadamizing Ridge Ave.; D. Folz & Son, Cincinnati, $26,989 with 4 x 21-in. limestone curb and 6 x 16-in. gutter flag, or $28,073 with concrete combined curb and gutter; Geo. M. Murdock & Co., Norwood, $27,198 or $27,750; Wilson Finey, Sharonville, $27,708 or $25,500.

TOLEDO, O.—The following lowest bids have been received: For paving Tecumseh St.—Jas. D. McNaghten, Cleveland, Medina stone, $5,445; vitrified brick, $5,743; Hallwood blocks, $6,718; blue granite blocks, $5,743; Trinidad asphalt, $5,585; Bermuda asphalt, $5,585; cedar blocks, with Medina curb, $5,768; with Berea curb, G. H. Bodette, $5,394. East Broadway.—Jas. D. McNaghten, Medina stone, $17,207; vitrified brick, $17,357 with either Berea or Medina curb; G. H. Bodette, cedar blocks, $16,321 with Berea curb, or $17,137 with Medina curb.

CHICAGO, ILL.—Bids are asked until Dec. 9 for 74,000 cu. yds. grading in Wentworth Ave. H. J. Jones, Comr. Pub. Wks.

ELECTRIC LIGHT AND POWER.

COTTAGE CITY, MASS.—The petition of the Cottage City Electric Light & Power Co. has been granted by the selectmen of this town. The plant, which will cost $60,000, will be located near Eastville so as to supply light and power to the village of Vineyard Haven. The grant requires the furnishing of electric lights, both arc and incandescent, for houses during the entire year.

HINGHAM, MASS.—The Boston "Herald" states that the proposed electric light plant will probably be in operation by July 1. The town voted six months ago to issue $30,000 worth of bonds to defray the cost of the system, the understanding being that no action toward constructing the plant should be taken till the bonds were placed. Now that wealthy residents of the town stand ready to purchase the bonds there is nothing in the way of carrying out the scheme.

NEW YORK, N. Y.—The gas commission will receive bids until Dec. 11 for public lighting during 1894.

MADISONVILLE, O.—The water-works and electric light trustees have awarded a contract to the Fort Wayne Electric Light Co., at $8,896, and a contract for engine and boilers to the Lane & Bodley Machine Co., Cincinnati, at $3,400; the whole to be completed by next February.

RICHMOND, IND.—Bids are asked until Dec. 18 for the street lighting; population, 20,000. Chas. G. Swain, Cy. Clk.

TOPEKA, KAN.—Press reports state that the contract for the construction of the dam across the Kansas River has been awarded by the Chicago-Topeka Light, Heat & Power Co. to Hlero B. Herr & Co. and Gen. Wm. Sooysmith, Chicago, at about $850,000. Work is to be commenced at once and the dam completed by July 1, 1894.

NEW COMPANIES.—Pioneer Electric Power Co., Ogden, Utah; $1,000,000; to construct a dam across the Ogden River; Pres., Geo. Q. Cannon; Gen. Man., F. G. Cannon; Ch. Engr., C. K. Bannister.——La Junta Electric Co., La Junta, Colo.; $25,000; Chas. F. Lacombe, A. G. Bentley, G. A. Goddard.——Northwestern Telephone & Electric Co., Milwaukee, Wis.; $50,000; A. B. Ferdinand, H. C. Dodge, H. H. Spencer.——Hough Electric Co., San Francisco, Cal.; E. S. Hough, Jos. Hough, Le Roy G. Harvey, J. M. Beck and others of Oakland, Cal.——Princeton Light & Power Co., Princeton, Ind.; $25,000; R. N. Parrett, L. Rothschild, G. P. Kidd.

CONTRACT PRICES.

PUMPING ENGINES.—Mankato, Minn.—The following bids were opened Nov. 25 for a 1,500,000-gallon pumping engine, to work against 223 ft. head:

Bidders.	—Cyl. diam., ins.— h. p.	l. p.	Stroke. wat'r.	ins.	Price.
Laidlaw-Dunn-Gordon Co.,	14	22	12	18	$1,800
" " " "	14	20	12	18	1,650
Knowles Pump Co	14	20	12	18	1,750
" " "	14	20	12	12	1,450
Blake Pump Co	14	14	12	18	1,950
" " "	Including condenser				2,700
Dean Bros., Indianapolis	12	18	12	12	1,095
H. R. Worthington	14	20	12½	15	1,850
Stillwell-Bierce & Smith-Vaile Co	12	14	20	20	1,945
Stillwell-Bierce & Smith-Vaile Co	12	14	20	15	1,800
St llwell-Bierce & Smith-Vaile Co	12	14	20	12	1,530
Deane Pump Co., Holyoke,	12	18½	11¼	18	
" " " "	14	20	12¼	18	1,925
" " " "	12	18	11¼	18	2,370

The supply will be pumped from two artesian wells through 12-in. pipe, with 10 to 20 lbs. pressure, to reservoir 4,700 ft. distant. M. B. Haynes, Cy. Engr.

WATER-WORKS.—Spokane, Wash.—The total bids for the proposed new water-works were published in our issue of last week, that of L. J. Martin, at $129,781, being much the lowest. Mr. Martin's bid in detail was as follows:

Dam			$27,500.00
Range ashlar,	506 cu. yds., at		.16
Range rubble,	1,908 " " "		5.50
Common "	1,540 " " "		4.25
1-2-3 concrete,	1,160 " " "		4.50
1-3-5 "	310 " " "		4.00
1-4-8 "	205 " " "		3.50
Cut stone,	4,650 cu ft., at		.80
Boulder gravel,	70,080 cu. yds., at		.19
Gravel,	104,400 " " "		.16
Fill,	12,060 " " "		.15
Paving,	2,200 " " "		.90
Headgate			2,500.00
Flumes,	70,000 lbs., at		.06¼
Flume gates,	5, at		900.00
Power-house,	at		4,500.00
Solid rock excavation,	at		1.00
Puddling			.25

LEVEE WORK.—Edwardsville, Ill.—The commissioners of the Chouteau, Nameoki and Venice drainage and levee district have let a contract to build a levee of 56,000 cu. yds. to Sutherland & La Rue, St. Louis, at 14¾ cts. per cu. yd. A contract for 73,000 cu. yds. was awarded at 11½ cts.

GRADING.—Paterson, N. J.—A contract for grading 2,500 cu. yds. in Dey St. has been awarded to Francis Murray, at 14 cts. per cu. yd., the other bids being Nelson Casson, 17 cts.; Wm. Moore, 23 cts.; John De Riper, 18 cts.; Louis Fredericks, 18¾ cts.; A. Dunn, 17 cts.; Jeremiah Connell, 28 cts.; David Arnold, 22 cts.

SEWERS.—Olean, N. Y.—Bids were opened Nov. 21 for a 6 to 20 in. pipe sewer, in three sections, and the contract was awarded in each case to the lowest bidder, the total bids being as follows: 1, W. H. Simpson, Olean, $8,982, $4,950, $976; 2, MacGregor, Hughes & Dodge, Buffalo, $8,711, $5,390, $884; 3 M. Albrecht, Olean, $8,998, $4,975, $982; 4, W. H. Mandeville, Olean, $11,844, $7,405, $1,058; McGuire & Savage, Olean, $1,033 for section 3. C. S. Giles, Cy. Engr., informs us that the prices bid for pipe include all excavation, pipelaying and back filling, the itemized bid for section 1 being as follows:

	1.	2.	3.	4
24-in. cast iron pipe, 60 ft.	$3.00	$4 00	$3 25	$6 20
21 in. tile pipe, 240 ft.	1.45	1.30	1.45	2.06
20-in. " " 3,500 ft.	1.26	1.15	1.26	1.64
15-in. " " 1,605 ft.	.79	.77½	.79	1.00
12 in. " " 550 ft.	.62	.61	.62	.72
10-in. " " 856 ft.	.46¼	.57½	.46½	.71
8-in. " " 600 ft.	.40	.40	.40	.67
20-in. Y branches, 18	2.25	1 25	2.25	3.00
15 in. " " 60	1.35	.85	1.35	2 00
12-in. " " 18	.90	.60	.90	1.50
10 in. " " 20	.70	.35	.70	1.00
Catch basins, 17	40.00	50.00	40.00	45.00
Lampholes, 4	10.00	10.00	10.00	15 00
Manholes, 17	40.00	40.00	40.00	50.00
4 in. drain pipe	.02	.10	.02	.10
Rock excavation	.50	2.75	.50	.10
Extra concrete	1.20	4.00	1.25	4.50
Rubble masonry	1.00	5.00	1.00	.50
Extra planking	9.00	12.00	9.00	10.00
Sheet piling	9.00	12 00	9.25	10.00

SEWER PIPE.—Washington, D. C.—The district commissioners have opened bids for furnishing and delivering sewer pipe, the items being as follows: a, 6-in. pipe, per lin. ft.; b, 8-in.; c, 10-in.; d, 12-in.; e, 15-in.; f, 18-in.; g, 21-in.; h, 24-in.; k, 8 x 6 in. branches, each; m, 10 x 6 in. branches; n, 18 x 6 in. branches; o, 21 x 6 in. branches; p, 24 x 6 in. branches.

Angus Lamond, Takoma, D. C.: a, 7¼ cts.; b, 11¼ cts.

Freeman Fire Clay Co., Freeman, O.: a, 8 cts.; b, 12½ cts.; c, 19 cts.. d, 25 cts; e, 40 cts.; f, 52 cts.; h, $1; k, 60 cts.; m, 87 cts.; n, $2.40; p, $4.50.

Potomac Terra Cotta Co., Washington, D. C.: a, 5½ cts.; b, 8¼ cts.; c, 10½ cts.; d, 12 cts.; e, 19 cts.; f, 27 cts.; g, 41 cts.; h, 54 cts.; k, 36 cts.; m, 46 cts.; n, $1.22; o, $1.82; p, $2.44.

McMahon, Porter & Co., New Cumberland, W. Va.: a, 67½ cts.; b, 10 8-10 cts.; 14 4-10 cts.; d, 18 cts.; e, 27 cts.; f, 36 9-10 cts.; g, 54 9-10 cts.; h, 81 cts.; k, 57 cts.; m, 66¼ cts.; n, $1.805; o, $2.613; p, $3.563.

T. Somerville & Sons, Washington, D. C.: a, 6 cts.; b, 8¾ cts.; d, 15 cts.; e, 23½ cts.; f, 32¼ cts.; g, 47 cts.; n, 65 cts.; k, 38 cts.

State Line Sewer Pipe Co., East Palestine, O.: a, 7 cts.; b, 10¼ cts.; c, 15¼ cts.; d, 20 cts.; e, 29 cts.; f, 40 cts.; g, 62 cts.; h, 81 cts.; k, 48 cts.; m, 70 cts.; n, $1.90; o, $2.81; p, $3.66.

John Robrecht, Wheeling, W. Va.: a, 6.3 cts.; b, 9 45-100 cts.; c, 13 65-100 cts.; d, 17 85-100 cts.; e, 24 35-100 cts.; f, 38 85-100 cts.; g, 57¾ cts.; h, 74 55-100 cts.; k, 42 cts.; m, 60 9-10 cts.; n, $1.77; o, $2.50; p, $3.37.

DRAINAGE CANAL.—Chicago, Ill.—Bids were opened Nov. 29 for constructing five miles of the drainage canal, being sections G, H, I, K, L and M, between the east line of range No. 12 east of the third principal meridian at Summit and Corwith, Ill., and consists of the excavation of 6,534,000 cu. yds. of earth. The lowest bids for the six sections aggregate $1,535,797 and were as follows, all the bidders being residents of this city:

G.	Casgrain & McDonald	1,350,000 cu. yds., at 28	cts.
H.	Galan & Byrne	1,100,000 " " " 29	cts.
I.	Christie & Lowe	1,135,000 " " " 25	cts.
K.	" "	1,157,000 " " " 23	cts.
L.	Heidenreich Co	1,092,000 " " " 19.7	cts.
M.	" "	710,000 " " " 21.7	cts.

The other bidders were: Fred Stafford, Chicago; Halversen, Richards & Co., Minneapolis; W. A. McGillis & Co., A. J. McBean, William Innes and C. E. Loss & Co., Chicago; McCormick Mocan, Pittsburg; Winston Bros., Minneapolis; Mason, Hoge & Co., Frankfort, Ky.; John J. McClaughry, Summit, Ill.; Hayes Bros., Janesville, Wis.; McMahon & Montgomery Co., Chicago; Brodhead & Hickey, Fairview, N. J.; William Dolose & Co.; Chicago; Streeter & Kenefick, Summit, Ill.; Hoover & Mason, Kansas City, Mo.; Ryan & McDonald Const. Co., Baltimore, Md.; Dawson, Symmes & Co., Chicago; Patterson & Shipman, Catlettsburg, Ky.; F. H. Clement, New York; Ricker, Lee & Co., Galveston, Tex.

MISCELLANEOUS CONTRACTS AND SUPPLIES.

FIRE HOSE.—Linwood, O.—Bids are asked until Dec. 12 for 1,000 ft. of 2½-in. fire hose. H. E. Byron, Vil. Clk.

DREDGING.—Brooklyn, N. Y.—Bids are asked until Dec. 18 for dredging Gowanus Canal. John P. Adams, Comr. Cy. Wks.

WHARF.—Fort McHenry, Md.—Bids are asked until Dec. 27 for constructing a wharf at this place. Lieut. A. Cronkhite, U. S. A.

WATER POWER.—Paw Paw, Mich.—It is stated that this city will give a liberal bonus to capitalists who will use certain water power near the city.

LOCKS AND DAMS.—Dallas, Tex.—The Trinity Navigation Co. has ordered the immediate construction of a set of locks and dams a short distance below McCommas' Bluff, on the Trinity River. The plans include the excavation of 12,000 cu. yds. of rock and 1,000 cu. yds. of clay; estimated cost, $8,000.

LEVEE WORK.—Memphis, Tenn.—Bids will be received at the U. S. Engineer Office until Dec. 19 for 1,600,000 cu. yds. of work in the Upper Tensas levee district and 500,000 cu. yds. in the Middle Tensas district. Capt. C. McD. Townsend, U. S. A.

Baton Rouge, La.—R. M. Quigley & Co. desire to sublet 300,000 cu. yds. of work in the Pontchartrain district. Apply at Meyer Hotel.

MACHINE SHOP, ETC.—Pittsburg, Pa.—Bids are asked until Dec. 15 for machine shop and warehouse for the Westinghouse Electric Mfg. Co., at Brinton, Pa. Press reports state that the machine shop will be 754 x 233½ ft. and the warehouse 754 x 76 ft., and to handle the goods in these buildings there will be required two 30-ton traveling cranes, eight 10-ton and two 2-ton cranes. The six skylights will each be 175 x 20 ft. East Pittsburg Improt. Co., Room 20 Westinghouse Bldg.

INDUSTRIAL NOTES.

THE BROOKS LOCOMOTIVE WORKS, Dunkirk, N. Y., are building a mogul passenger engine for the Baltimore & Lehigh.

THE BALDWIN LOCOMOTIVE WORKS, Philadelphia, Pa., have an order for 70 locomotives for the Atchison, Topeka & Santa Fe and for six compound freight and four compound passenger engines for the Philadelphia, Reading & New England.

J. G. GLAVER & CO., Monadnock Block, Chicago, are erecting several flat buildings and the new Masonic Hall on North Clark St., all in Chicago.

THE RIEHLE BROS. TESTING MACHINE CO., Philadelphia, Pa., is fitting up a physical test laboratory for Chas. F. McKenna, who has associated himself with the chemical laboratory conducted by Dr. Gideon E. Moore, at 221 Pearl St., New York. It will have a Riehle vertical screw power testing machine of 100,000 lbs. capacity, with a "Nonpareil" automatic card attachment. There will also be a Riehle cement testing machine, with worm gear, crushing tools and rubber pointed cement grips.

ALEXANDER, HILL & ENRICHT, Chamber of Commerce Building, Chicago, are engaged as consulting and constructing engineers for public improvements as follows: Wilmette, Ill., water-works and sewers; Lake Forest and La Grange, Ill., sewers and paving, and West Pullman, Ill. All of the above work is now nearly completed.

THE NATIONAL SWITCH & SIGNAL CO., Easton, Pa., has opened offices in the Monadnock Block, Chicago, with Charles Hansel, C. E., as western manager, in charge of all business west of Pittsburg.

ELEVATORS.—The Seckner Contracting Co., Chicago, Ill., has a contract for building an elevator for P. H. Winters at 63d St., near Union St., Chicago. It has recently completed an elevator for F. Marshall, at 46th St. and Wabash R. R.; also one on Wentworth Ave., both in Chicago.

THE RELIANCE GAGE CO., Cleveland, O., reports that its water columns have been adopted by the manufacturers of the Stirling and the Climax boilers for exclusive use on these boilers in the future. They were in use on these boilers at the World's Columbian Exposition.

NEW COMPANIES.—Griffin Car Wheel Co., Chicago, Ill.; $1,000,000; T. A. Griffin, G. G. Willard and W. W. Evans. Norristown Steel Co., Norristown, Pa.; Pres., H. H. Haven; Gen. Man., G. J. Humbert. Anderson Coke Gas, Power & Reduction Co. Chicago, Ill.; $1,000,000; James C. Anderson, F. J. Smith and J. B. Gascoigne. St. Clair & Erie Ship Canal Construction Co., Madison, Wis.; L. F. Luken, T. W. Money and D. F. Henry. Sharler & Schniglan Co., Chicago, Ill.; $125,000; Robert A. Sharler, Charles R. Schniglan and Robert P. Lamont.